A Review on YOLO and CNN Powered real time Accident Detection System for road safety

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Abstract: Road accidents remain a significant source of human suffering and economic loss worldwide. Traditional methods of accident detection often rely on manual reporting, resulting in delayed emergency response and potentially preventable fatalities. This thesis presents an automated Accident Detection System utilizing YOLOv8 and Convolutional Neural Networks (CNNs) to enhance real-time accident recognition and reporting. YOLOv8, known for its high-speed and accurate object detection, serves as the primary tool for identifying potential accident events. Meanwhile, CNNs provide additional analytical power, identifying complex patterns within accident scenes to improve detection accuracy. By significantly reducing response times, this system aims to improve emergency response efficiency, thereby contributing to saving lives and minimizing accident-related losses. This study demonstrates the potential of advanced deep learning algorithms to transform accident detection, providing a reliable alternative to traditional methods.

Keywords: Road accidents, Accident detection, YOLOv8, Convolutional Neural Networks (CNNs), Real-time detection, Emergency response, Object detection.

INTRODUCTION

In the context of contemporary road safety challenges, timely and accurate detection of accidents is critical for mitigating their adverse effects. Prompt intervention by emergency services can greatly diminish the severity of road accidents by speeding up medical assistance and clearing the scene, thus preventing secondary accidents caused by road congestion or debris. Traditional methods of accident detection, such as relying on human eyewitnesses or manual monitoring of surveillance cameras, often suffer from significant limitations. These methods can be slow, subjective, and prone to inaccuracies, leading to delays in emergency response and potential exacerbation of the accident's consequences. To address these issues, this research introduces the development of an advanced automated Accident Detection System, which integrates sophisticated machine learning algorithms to overcome the limitations of conventional detection techniques. The system aims to achieve the following goals: 1. Accurate Accident Detection 2. Reduction of Response Times 3. Enhanced Road Safety The development of a transit has been the generative power for human beings to own the very best civilization above creatures within the earth. Speed is one in every of the foremost important and basic risk factors in driving. Despite many efforts taken by different governmental and non-governmental organizations all round the world by various programs to aware against careless driving, yet accidents are happening place every now and then. However, most of the lives could have been saved if the emergency services received the crash information in time. Accidents could have been prevented only if the emergency services may well be provided at the place of accident at the correct time. So as this, efficient automatic accident detection with an automatic notification to the emergency services with the live accident location is the most needed to save the precious human life.[1] Adaptive Multiple Region Segmentation Based On Outdoor Object Detection focuses on improving outdoor image segmentation using adaptive global clustering. It groups regions based on color and texture, simplifying the segmentation process compared to traditional methods like k-means clustering. The method effectively identifies background objects such as the sky, trees, and ground, improving segmentation quality, especially in natural scenes. It outperforms other leading segmentation techniques by addressing challenges like strong reflections and over-segmentation, enhancing object boundary detection and background identification.[2] The high demand of automobiles has also increased the traffic hazards and the road accidents. Life of the people is under high risk. This is because of the lack of best emergency facilities available in our country. An automatic alarm device for vehicle accidents is introduced in this paper. This design is a system which can detect accidents in

significantly less time and sends the basic information to first aid centre within a few seconds covering geographical coordinates, the time and angle in which a vehicle accident had occurred. This alert message is sent to the rescue team in a short time, which will help in saving the valuable lives. A Switch is also provided in order to terminate the sending of a message in rare case where there is no casualty, this can save the precious time of the medical rescue team.[3] AI and IOT Based Road Accident Detection and Reporting System by Varsha Patil, Adesh More, Mitali Mahajan, and Hemant Gholap proposes an AI and IoT-based road accident detection and reporting system to reduce fatalities caused by delayed medical assistance. Using sensors like vibration, accelerometer, alcohol, IR, 2 GPS, camera, and Raspberry Pi, the system detects accidents and sends real-time data to the cloud. The data is then transmitted via the Virtuo 6 application, enabling a quick emergency response. This smart system aims to minimize rescue delays and save lives by ensuring timely medical intervention following accidents.[4] The review paper on Vehicle Accident Detection, Tracking and Notification Systems by Dr. Bharat Naresh Bansal and Vivek Garg analyzes various vehicle accident detection, tracking, and notification systems. It highlights how these systems use sensors like accelerometers or vibration detectors to automatically detect accidents and immediately notify registered contacts, such as family members, police, or hospitals, via SMS or email. With the integration of GPS, these systems provide precise accident location data. The paper discusses the use of technologies like GSM and Wi-Fi in these systems, comparing their strengths, limitations, and potential improvements for future applications.[5]

PROBLEM DEFINITION

- Road accidents pose a significant threat to public safety, often resulting in injuries, fatalities, and traffic disruptions. Traditional accident detection systems, such as manual reporting or basic sensor technologies, fail to offer real-time detection and response, leading to delays in emergency assistance. As a result, critical minutes are lost, which could have otherwise minimized casualties and provided timely aid to the injured.
- Additionally, current detection methods struggle
- to accurately identify and classify different types of accidents in real-time, especially in complex and dynamic traffic environments. The systems also consume considerable computational resources, limiting their deployment in high-traffic or resource-constrained settings.
- Moreover, existing solutions do not seamlessly integrate with alert systems, delaying the communication of crucial information to emergency responders.

OBJECTIVES

- Accurate Accident Detection:
- o Robust System Design: Create an architecture for efficient real-time video stream processing.
- o Multi-Class Classification: Train the system to identify various accident types using a diverse dataset.
- o Model Optimization: Fine-tune YOLOv8 and CNN for precise accident identification.
- o Robustness in Variability: Ensure adaptability to different environmental conditions.
- Timely Alert Generation:
- o Real-Time Processing: Implement algorithms for fast video feed processing.
- o Automatic Alert Mechanism: Develop a system to generate alerts for emergency services upon accident detection.
- Reliable Communication Protocol:

o Set up a communication protocol that ensures alerts are transmitted with minimal latency, allowing emergency services to receive timely and actionable information for faster intervention.

LITERATURE SURVEY

[1] Paper Name :- Accident Detection And Alert System
Author:- G. Siri, G. Priyanka, B. Divya, G. Sameera, Ms. M. Pallavi
Publication:- International Research Journal of Modernization in Engineering Technology and Science June-2022
Explanation:- The development of a transit has been the generative power for human beings to own the very best civilization above creatures within the earth. Speed is one in every of the foremost important and basic risk factors in driving. Despite many efforts taken by different governmental and non-governmental organizations all round the world by various programs to aware against careless driving, yet accidents are happening place every now and then. However, most of the lives could have been saved if the emergency services received the crash information

in time. Accidents could have been prevented only if the emergency services may well be provided at the place of accident at the correct time. So as this, efficient automatic accident detection with an automatic notification to the emergency services with the live accident location is the most needed to save the precious human life.

[2]   Paper Name:- Adaptive Multiple Region Segmentation Based On Outdoor Object
Author:- Anju J.A, P. Jenopaul
Publication:- International Journal of Engineering Research & Technology, Afril-2013
Explanation:- Adaptive Multiple Region Segmentation Based On Outdoor Object Detection focuses on improving outdoor image segmentation using adaptive global clustering. It groups regions based on color and texture, simplifying the segmentation process compared to traditional methods like k-means clustering. The method effectively identifies background objects such as the sky, trees, and ground, improving segmentation quality, especially in natural scenes. It outperforms other leading segmentation techniques by addressing challenges like strong reflections and over-segmentation, enhancing object boundary detection and background identification.

[3]   Paper Name:- Vehicle Accident Detection System By Using Gsm And Gps
Author:- Gowshika. B, Madhu Mitha. G, Jayashree. S, S. Mutharasu
Publication:- International Research Journal of Engineering and Technology Jan 2019
Explanation:- The high demand of automobiles has also increased the traffic hazards and the road accidents. Life of the people is under high risk. This is because of the lack of best emergency facilities available in our country. An automatic alarm device for vehicle accidents is introduced 5 in this paper. This design is a system which can detect accidents in significantly less time and sends the basic information to first aid centre within a few seconds covering geographical coordinates, the time and angle in which a vehicle accident had occurred. This alert message is sent to the rescue team in a short time, which will help in saving the valuable lives. A Switch is also provided in order to terminate the sending of a message in rare case where there is no casualty, this can save the precious time of the medical rescue team.

[4]   Paper Name:- AI and IOT Based Road

Accident Detection and Reporting System
Author:- Adesh More, Mitali Mahajan, Hemant Gholap
Publication:- Ijraset Journal For Research in Applied Science and Engineering Technology, https://doi.org/10.22214/ijraset.2023.48904
Explanation:- AI and IOT Based Road Accident Detection and Reporting System by Varsha Patil, Adesh More, Mitali Mahajan, and Hemant Gholap proposes an AI and IoT-based road accident detection and reporting system to reduce fatalities caused by delayed medical assistance. Using sensors like vibration, accelerometer, alcohol, IR, GPS, camera, and Raspberry Pi, the system detects accidents and sends real-time data to the cloud. The data is then transmitted via the Virtuo 6 application, enabling a quick emergency response. This smart system aims to minimize rescue delays and save lives by ensuring timely medical intervention following accidents.

[5]   Paper Name:- Vehicle Tracking and Accident Notification System
Author:- Racheal Dias, Vishakha Ghike, Jennifer Johnraj, Nicholas Fernandes, Anita Jadhav
Publication:- IEEE 2018 3rd International Conference for Convergence in Technology (I2CT)
Explanation:- The review paper on Vehicle Accident Detection, Tracking and Notification Systems by Dr. Bharat Naresh Bansal and Vivek Garg analyzes various vehicle accident detection, tracking, and notification systems. It highlights how these systems use sensors like accelerometers or vibration detectors to automatically detect accidents and immediately notify registered contacts, such as family members, police, or hospitals, via SMS or email. With the integration of GPS, these systems provide precise accident location data. The paper discusses the use of technologies like GSM and Wi-Fi in these systems, comparing their strengths, limitations, and potential improvements for future applications.

METHODOLOGY

1. YOLOv8 Features:
o   Speed: Essential for real-time accident detection.
o   Detection Heads: Three scales for detecting various object sizes.
o   Training: Optimized on a dataset with annotated accident images.

2. Integration Process:
o   Data Collection: Video streams from road

surveillance cameras.
o Preprocessing: Enhances video quality (resizing, normalization, augmentation).
o Model Initialization: Uses pre-trained YOLOv8 weights. o Training: Fine-tunes model with labeled accident images.
o Real-time Detection: Identifies accidents in video frames with bounding boxes.
o Alert Generation: Sends immediate alerts to authorities.
o Performance Evaluation: Assesses accuracy, speed, and robustness.

3. YOLOv8 Configuration Parameters:
o Batch Size: Influences memory usage and training speed.
o Learning Rate: Controls optimization step size.
o Anchor Boxes: Helps predict bounding boxes for various scales.
o IoU Threshold: Filters overlapping boxes to improve precision.
o Confidence Threshold: Minimum score for valid detection.
o NMS Threshold: Eliminates redundant boxes for confident detections.

4. System Components:
o Surveillance Cameras: Capture real-time video from strategic locations.
o Data Preprocessing: Optimizes video frames for analysis.
o YOLOv8 Algorithm: Detects and localizes accident-related objects.
o CNN Algorithm: Classifies accident types (collisions, rollovers).
o Alert Generation: Sends alerts for quick emergency responses.

5. System Functionality:
o Real-time Monitoring: Continuously analyzes video streams.
o Accident Detection: YOLOv8 marks accident-related objects.
o Accident Classification: CNN categorizes accident types.
o Alert Generation: Triggers immediate alerts for emergency services.
o Performance Evaluation: Ensures accuracy, speed, and robustness.Data flow Diagram
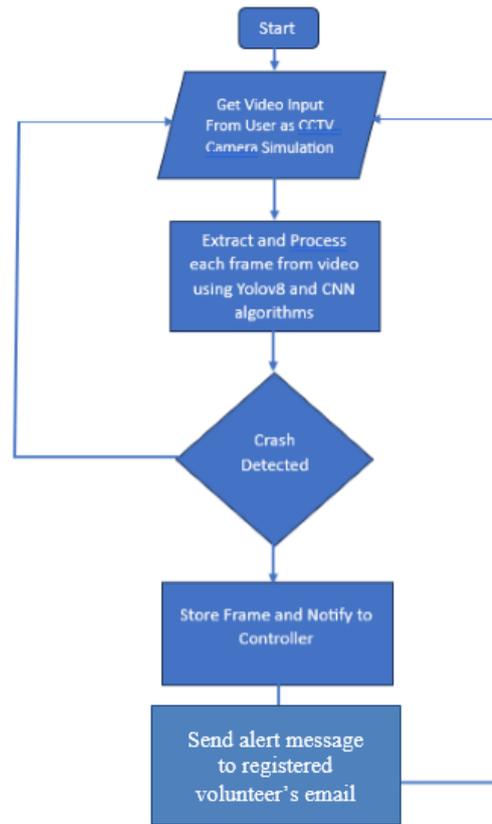
DATA FLOW DIAGRAM

Fig. Data flow Diagram

This system follow the following process as defined in flow diagram.

- Get CCTV Footage from Computer as a video Input
o Accessing the Video Input: Application provide get video button which will load the user selected video from computer to application .

- Extract and Process Each Frame
o Capture Frames: Continuously extract frames from the video feed using libraries like OpenCV in Python.
o Pre-process Frames: Convert frames into the required format (resize, normalize) and apply any necessary pre-processing, such as noise reduction.

- Use YOLO for Object Detection
o Load YOLO Model: Use a pre-trained or custom-trained YOLO model for real-time object detection.
o Detect Objects: Process each frame through YOLO to identify vehicles and their positions.

- Apply CNN for Crash Detection

o Load CNN Model: Use a pre-trained CNN model for crash detection or train one with labeled crash data.
o Process Frames: Feed the frames through the CNN to analyze and detect crash scenarios.
o Detect Crash
o Analyze Output: Combine YOLO and CNN outputs to confirm if a crash has occurred, using YOLO for vehicle positions and CNN for crash detection.

• Store Frame
o Save Relevant Frames: When a crash is detected, save the relevant frames to a

• Notify the Controller
o Send Alerts: Implement a notification system to alert the system controller with crash details, such as timestamp, location, and severity.

• Send Alert Messages to Registered volunteer's email address
o Send Alerts: Send alert messages to the registered volunteer's email address.

ADVANTAGES & DISADVANTAGES

Advantages

o Enhanced Safety: Faster emergency response and accurate accident detection save lives and reduce injury severity.
o Improved Efficiency: Real-time tracking and automated alerts streamline accident management and emergency services.
o Better Data Utilization: Comprehensive data collection and analysis improve system accuracy and road safety strategies.
o Enhanced Accuracy: Advanced technologies ensure precise detection and classification of accidents.
o Improved Emergency Coordination: Integrated communication and detailed information facilitate effective response and coordination.
o Scalability: Modular design allows easy adaptation and updates with new technologies.
o User-Friendly Interface: Intuitive dashboard and control panel for efficient system management.
o Privacy and Security: Secure data management ensures protection of sensitive information.

Disadvantages

o High Initial Cost: Implementing a sophisticated accident detection system involves significant investment in hardware and software, which may be unaffordable for rural or underdeveloped areas.
o Complex Setup and Maintenance: Proper installation and ongoing maintenance are challenging and can increase operational costs due to the need for camera placements and model training.
o Environmental Limitations: The system's accuracy can be impacted by adverse weather, poor lighting, and obstructions, requiring extensive model training to handle diverse conditions.
o Privacy Concerns: Continuous surveillance may raise privacy issues and necessitate strict regulations to protect data and prevent misuse.
o Dependency on Infrastructure: The system's effectiveness is reliant on stable infrastructure like power and internet connectivity, which can be problematic in areas with frequent outages

CONCLUSION

The YOLOv8-based accident detection system, when integrated with Convolutional Neural Networks (CNN), enhances the reliability and efficiency of road safety measures. Counteracting the limitations of traditional methods, this approach automates real-time accident detection, which substantially reduces response times and triggers timely alerts to emergency services. The minimization of human intervention paired with improved accuracy positions this system as a vital tool for modern traffic safety management. The system's effectiveness not only aids in injury reduction and saves lives but also elevates the efficiency of emergency response, making a substantial impact on traffic safety dynamics..

REFERENCES

[1] G. Siri, G. Priyanka, B. Divya, G. Sameera, Ms. M. Pallavi, "Accident Detection and Alert System", Volume:04/Issue:06/June-2022

[2] Anju J.A, P. Jenopaul, "Adaptive Multiple Region Segmentation Based On Outdoor Object Detection", Vol. 2 Issue 4, April – 2013

[3] Gowshika. B, Madhu Mitha. G, Jayashree S, S. Mutharasu, "VEHICLE ACCIDENT DETECTION SYSTEM BY USING GSM AND GPS", IRJET, Volume 6, Issue 1, Jan, 2019

[4] Varsha Patil, Adesh More, Mitali Mahajan, Hemant Gholap, "AI and IOT Based Road Accident Detection and Reporting System",

Volume 11 Issue V May 2023

[5] Dr. Bharat Naresh Bansal, Vivek Garg, "A Review paper on "Vehicle Accident Detection, Tracking and Notification Systems"- A comparative study", Vol-ume: 08 Issue: 02 | Feb 2021

[6] Sanskruti Patel, Atul Patel, "Object Detection with Convolutional Neural Networks", DOI: 10.1007/978-981-15-7106-0_52

[7] Uma N, Saktheeswari R, In-dumathi A, Sugacini M, Kavishree S, "Smart Accident Detection and Alert System", Volume 11, Issue 03, 2023

[8] Dawn Wilson , Dr. Manusankar C. , Dr. Prathibha P H, "Analytical Study on Object Detection using Yolo Algorithm", Volume 7, Issue 8, August 2022

[9] Seetam Emmanuel, F. E. Onuodu, "Object Detection using Convolutional Neural Network Transfer Learning", Volume 10, Issue 3, 2022.

[10] Wang, Z., Zhan, J., Duan, C., Guan, X. & Yang, K. Vehicle detection in severe weather based on pseudo-visual search and HOG–LBP feature fusion. Proc. Inst. Mech. Eng. Part D: J. Autom. Eng. 236, 1607–1618.
https://doi.org/10.1145/2964284.2967280 (2022).