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

An Automatic Vehicle Accident Detection using Neural Networks

[1]Shrikant Shinde, [2]Snehal Birajdar, [3]Vaishnavi Kshirsagar, [4]Vishal Patil, [5]Aarti Swami
[1]Assistant Professor, [2, 3,4,5]Student
[1,2,3,4,5]Department Of Computer Engineering,
[1,2,3,4,5]Sinhgad Institute of Technology And Science, Narhe, Pune, 411041, India.

Abstract : Neural networks play a crucial role in accident detection by providing a powerful tool for processing and analyzing various types of data relevant to accidents. With population growth, the demand for vehicles has increased tremendously, which has created an alarming situation in terms of traffic hazards and road accidents. The road accidents percentage is growing exponentially and so are the fatalities caused due to accidents. However, the primary cause of the increased rate of fatalities is due to the delay in emergency services. Many lives could be saved with efficient rescue services. The delay happens due to traffic congestion or unstable communication to the medical units. The implementation of automatic road accident detection systems to provide timely aid is crucial. Many solutions have been proposed in the literature for automatic accident detection and various machine learning techniques. With such high rates of deaths associated with road accidents, road safety is the most critical sector that demands significant exploration. In this paper, we present a critical analysis of various existing methodologies used for predicting and preventing road accidents, highlighting their strengths, limitations and challenges that need to be addressed to ensure road safety and save valuable lives. A Convolutional Neural Network (CNN) is a type of artificial intelligence model that's particularly good at processing and analyzing visual data, such as images and video. In our proposed system, we implemented a vehicle accident detection using convolutional neural networks (CNN) to detect road accidents in inhabited areas, highways. CNNs have been applied to various fields, including automatic accident detection systems, to improve road safety. In the context of automatic accident detection systems, CNNs can be used to analyze images or video footage from cameras installed on roads and vehicles.

Keywords: Video Detection, Convolutional Neural Network, Feature extraction, Accident detection, Road safety.

I. INTRODUCTION

We developed an application for detection of accident of people in public places in real time. Our application can be used in surveillance at places like malls, airports, railway stations, etc. where there is a risk of robbery or a shooting attack. We will be using deep learning and neural networks to train our system. And prevent this type of accident in early stage. Due to rapid growth of world population, the demand for vehicles has increased tremendously, resultantly problems of traffic congestion and road accidents has also increased. The general population's life is under high risk, if any accident occurs there's a long reaction time which increments the number of deaths, therefore an automatic accident detection system must exist to overcome this situation. Accident detection systems are advanced technological solutions designed to monitor and detect unexpected events in various environments. Accident detection systems are advanced technological solutions designed to monitor and detect unexpected events in various environments. The goal of accident detection systems is to enhance safety for individuals property. Machine learning is used to implement the project. Image processing technique is used to detect the accident. The primary objective of Accident detection systems is to identify incidents as soon as they occur. The key job of these systems is to provide early warnings using technology and data analysis. This helps minimize mistakes made by people and enhances safety overall. In the context of traffic safety, for instance, these systems can reduce the severity of road accidents and save lives. We plan to build an application for the detection of accidents of people in public places in real time. Our application can be used in surveillance at places like malls, airports, railway stations, etc. where there is a risk of robbery or a shooting attack. We will be using deep learning and neural networks to train our system. And prevent this type of accident in the early stage. Due to the rapid growth of the world population, the demand for vehicles has increased tremendously, resulting in problems of traffic congestion and road accidents has also increased. The general population's life is at high risk, if any accident occurs there's a long reaction time which increments the number of deaths, therefore an automatic accident detection system must exist to overcome this situation. It improves road safety, reduces human error, enhances response times, and leverages technological advancements. These systems have the potential to save lives, reduce economic costs, and create safer and more efficient transportation networks. These systems have the power to transform how societies respond to and mitigate the impact of traffic accidents, making roads safer for everyone.

The advancement of neural networks and increased processing power have led to the use of a variety of detection and classification models. These models have been used in many different domains, most notably video and image processing. In essence, traffic-accident detection is a pattern-classification problem, meaning that the pattern needs to be identified or divided into two categories: non-traffic accidents and traffic accidents. The backdrop information in video frames presents a barrier for traditional traffic accident recognition techniques, making it harder to reliably identify incidents. Furthermore, certain approaches require manual threshold adjustments to filter the background, which can increase the experimental complexity and computational time. Nowadays, road accidents have become very common. As more and more people are buying automobiles, the chances of road accidents are increasing day by day. In addition, compared to prior periods, people are now also more irresponsible. Not many people follow the traffic rules and in larger cities, there are various modes of transports available, the roads are becoming narrower day by day and the cities have become more crowded. Thus, road accidents are bound to happen. They cause loss of lives as well as material. Therefore, regardless of the method of transportation used, people need to be much more cautious when driving. Even those walking on foot are not safe because of the increase in these incidences. We read about accidents every day in the press, hear about them from family members, and occasionally even witness them first hand.

II. RELATED WORK

[1] Accident Detection Using Deep Learning(2020) Authors: Durgesh Kumar Yadav, Renu. Machine Learning CNN, RNN. High accuracy in detecting accidents, especially when trained on large and diverse datasets. Require large amounts of labeled data for training. [2] A Deep Learning based Accident Detection System(20- 20) Authors: Gokul Rajesh, Amitha Rossy Benny, Harikrishnan A, James Jacob Abraham. Deep Learning CNN An indicator of survival rates after detecting accidents is the time between the occurrence of accidents and the advent of medical care for the victim. Achieve high accuracy in accident detection tasks. Require large amounts of labeled data for training. [3] An application of a deep learning algorithm for automatic detection of unexpected accidents under bad CCTV monitoring conditions in tunnels(2019) Authors: Kyu Beom Lee, Hyu Soung Shin. Deep learning RCNN, Vehicles using this system can detect the vehicle ahead in real-time when the driver is driving the vehicle, and calculate the safety distance of the vehicle ahead. Operate in real-time, enabling immediate detection of accidents as they occur. Required to ensure its effectiveness. [4] Application of Vehicle Detection Based On Deep Learning in Headlight Control(2020) Authors: Zi-Han Huang, Chuin-Mu Wang. Deep Learning CNN, it possible to track a moving object in time, which is not usually achieved in conventional object detection frameworks. Enables adaptive headlight control, ensuring that headlights are focused on the road and surroundings. Requires large, diverse, and well-labeled datasets. [5] Real-Time Traffic Sign Detection using Capsule Network(2019) Authors: Neelavathy Pari S, Mohana T, Akshaya V. Machine Learning CNN, RNN Automatic detection of traffic signs is also important for automated intelligent driving vehicles or driver assistance systems. Capsule networks offer more interpretable feature representations compared to traditional convolutional neural networks (cnns). Capsule networks can be computationally intensive, especially as the network architecture becomes deeper and more complex. [6] Deep Spatio-Temporal Representation for Detection of Road Accidents Using Stacked Autoencoder(2018) Authors: Dinesh Singh, Student Member, IEEE, and Chalavadi Krishna Mohan, Member, IEEE. Deep Learning CNN In this paper, we propose a novel framework for automatic detection of road accidents in surveillance videos Stacked autoencoders can automatically learn hierarchical and abstract features from spatiotemporal data, allowing for the creation of rich representations of road accident scenarios. Training deep networks, especially stacked autoencoders, requires a large amount of labeled data and substantial computational resources. [7] A Detailed Study on Bangladeshi Road Sign Detection and Recognition(2019) Authors: Sk. Md. Masudul Ahsan, Sunanda Das, Shanto Kumar, Zannati La Tasriba. Machine Learning CNN, RNN Automatic road sign detection and recognition is crucial for autonomous Driver Assistance Systems (DAS). Accurate detection and recognition of road signs contribute significantly to road safety. Road signs can vary significantly in design, color, and layout, making it challenging to create a one-size-fits-all recognition system. [8] Pre-Activated 3D CNN and Feature Pyramid Network for Traffic Accident Detection(2020) Authors: Hyunwoo Kim, Seokmok Park, and Joonki Paik. Machine Learning CNN The proposed method consists of pre-activation ResNet and feature pyramid network (FPN) structure. 3D cans can process sequential frames as video volumes, capturing temporal patterns and motion cues. Implementing and fine-tuning pre-activated 3D cans and fans can be complex and may require significant expertise in deep learning and computer vision. [9] Computer Vision-based Accident Detection in Traffic Surveillance (2019) Authors: Dhananjai Chand, Savyasachi Gupta. Machine Learning CNN, RNN The probability of an accident is determined based on speed and trajectory anomalies in a vehicle after an overlap with other vehicles. Detect accidents in real-time, enabling swift response from emergency services, reducing response time, and potentially saving lives. Setting up a robust computer vision system can be expensive, involving costs related to highquality cameras, sensors, and advanced software development. [10] Real-Time Anomaly Detection and Localization in Crowded Scenes(2020) Authors: Mohammad Sabokrou, Mahmood Fathy, Mojtaba Hosseini. Machine Learning CNN In this paper, we propose a method for real-time suspicious detection and localization in crowded scenes. Identifying potential threats or criminal activities as they happen, enabling rapid response from security personnel. Real-time surveillance raises concerns about privacy rights. [11] Development of an Interpretable Maritime Accident Prediction System Using Machine Learning Techniques (2022) Authors: Gyeongho Kim, Unghoon Lim. Machine learning CNN. Resnet and feature pyramid network (VPN) structure. This improves the generaliz ability of accident detection models by reducing biases associated with visual features alone. Independent verification is necessary to determine whether the method indeed reduces biases and enhances generalization. [12] A New Approach to Traffic Accident Anticipation With Geometric Features for Better Generalizability(20- 23) Authors: Farhan Mahmood, Daehyeon Jeong, And Jeha Ryu. Neural Networks: Deep learning techniques like neural networks can be used for more complex and non-linear modeling but might be less interpretable. However, techniques like SHAP (Shapley Additive explanations) can be applied to make deep learning models more interpretable. The system can help improve safety in the maritime industry by identifying areas or conditions that pose a higher risk and recommending safety measures to mitigate those risks. Predictive systems must be used responsibly and ethically. There is a risk of biases in the data, and if not carefully managed, the system could reinforce existing biases or lead to unintended consequences. [13] A Proactive Accident Detection And Prevention System. Authors : Shrikant Shinde, Snehal Birajdar, Vaishnavi Kshirsagar, Vishal Patil, Aarti Swami. . In this paper, authors present a critical analysis of various existing methodologies used for predicting and preventing road accidents, highlighting their strengths, limitations, and challenges that need to be addressed to ensure road safety and save valuable lives. A Convolutional Neural Network is a type of artificial intelligence model that's particularly good at processing and analyzing visual data, such as images and video. In the context of automatic accident detection systems, it can be used to analyze images or video footage from cameras installed on roads and vehicles. CNNs are often considered better than FPNs and RNNs for certain tasks due to their ability to efficiently capture spatial hierarchies in data like images. FPNs are designed to address scale variation in object detection tasks.

III. PROBLEM STATEMENT

To develop a robust and efficient system that can accurately and rapidly identify traffic accidents or hazardous situations from visual data sources, such as surveillance cameras, dashcams, or traffic management systems. This system aims to provide real-time alerts to relevant authorities or emergency services to enable prompt response and minimize the impact of accidents on road safety.

IV. PROPOSED METHODOLOGY

CNN is Convolutional Neural Network it is one of the type of Neural Network. It is mostly designed for tasks like Image recognition ,Image Classification, object detection and well-suited for image and video analysis. CNN is best because it automatically learns patterns and features from raw pixel data. First step is Data Collection here we gather a dataset of road video footage from sources like traffic cameras, capturing various traffic scenarios. Preprocess the collected data by removing noise, resizing images for consistency, converting to binary format if needed, and transforming them to grayscale for simplicity. Perform additional preprocessing steps such as normalizing pixel values or enhancing contrast to prepare the data for feature extraction. After that utilize the preprocessed data to extract relevant features, such as edges, textures, and patterns, crucial for identifying potential accidents. Divide the images into meaningful segments or regions to focus the analysis on specific areas of interest, facilitating more accurate accident detection. Then Train a Convolutional Neural Network (CNN) with the preprocessed and segmented data, teaching the model to classify between normal and accident scenarios based on learned features. Then obtain the final output from the CNN, indicating whether an accident is detected in the input data. This output serves as the system's alert, triggering further actions or notifications in response to the identified incident.

A. System Architecture

Following figure 1 shows the system architecture for vehicle accident detection.

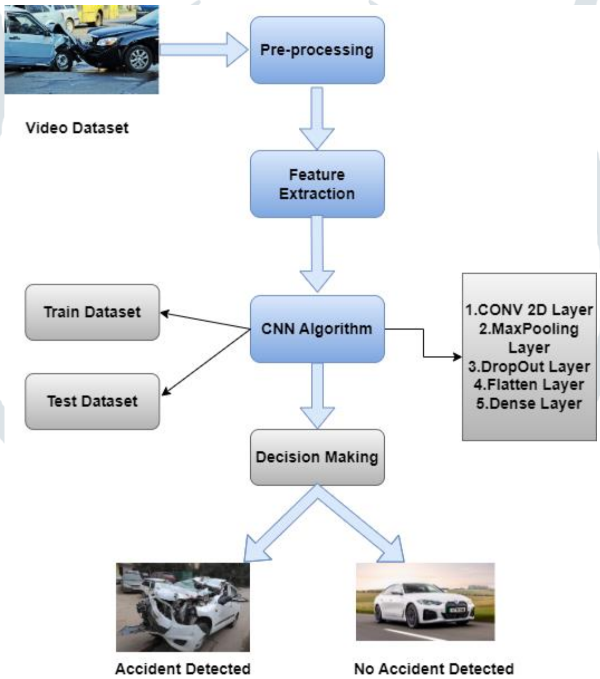

Fig 1. System Architecture for vehicle accident detection

- **Data Collection**: Collect sufficient data samples and legitimate software samples. The system begins with a dataset of videos, presumably containing footage from some kind of surveillance or monitoring system. The video dataset forms the foundation of the system. It may consist of recordings from various sources, such as CCTV cameras, dashcams, or surveillance drones. These videos capture real-world scenes and events, including both normal activities and potential accidents.
- **Preprocessing:** Before feeding the videos into the CNN, preprocessing steps are applied to clean and format the data. This might involve tasks such as resizing frames, normalizing pixel values, or removing noise from the videos. Preprocessing prepares the raw video data for input into the CNN. This involves several steps to clean, standardize, and enhance the videos for optimal performance during feature extraction. Some common preprocessing steps include:
  Resizing: Adjusting the resolution of video frames to a standard size suitable for CNN input.
  Normalization: Scaling pixel values to a common range (e.g., 0 to 1) to ensure consistency across videos.
  Noise Reduction: Removing or reducing noise, artifacts, or disturbances from the video frames using techniques like filtering or denoising algorithms.
  Frame Selection: Selecting key frames or segments of interest from the videos, especially if dealing with long or continuous footage.

- **Feature Extraction**: For each video’s extract the features using image processing. Each frame of the pre processed videos is passed through the CNN for feature extraction. The CNN automatically learns to extract relevant features from the frames, such as patterns, shapes, or motion cues, that are useful for detecting accidents.
- **CNN algorithm**: The CNN is trained on a labelled dataset of videos, where each video is labelled as either containing an accident or not. During training, the CNN learns to map the extracted features to the correct labels using techniques like backpropagation and gradient descent. After training, the performance of the CNN is evaluated on a separate testing dataset to assess its accuracy and generalization ability.
- **Train and Test Modelling**: Split the data into train and test data Train will be used for training the model and Test data to check the performance.
- **Modelling**: CNN. Combine the training deep learning algorithms and establish a classification model.
- **Decision Making**: Once the CNN is trained and tested, it can be used to make predictions on new, unseen videos. The output of the CNN indicates whether an accident is detected in each video. The output of the CNN represents the model's prediction regarding whether an accident is detected in each video. This decision-making step typically involves setting a threshold or confidence level for classifying videos as either containing an accident or not. If the predicted probability of an accident exceeds the threshold, the system concludes that an accident has occurred.

If an accident is detected, the system triggers an action to send a Gmail alert. This action could be implemented using an application programming interface (API) for sending emails from the system to designated recipients. The email alert may include relevant information such as the location, time, and nature of the detected accident, enabling recipients to respond promptly and appropriately. By combining these components, the architecture enables real-time detection of accidents in video footage and facilitates timely communication and response to mitigate potential risks or damages.

B. Algorithm

CNN is a deep neural network used in visual image processing. CNNs have managed to achieve superhuman performance on some complex visual tasks. Convolutional Neural Network (CNN) is the extended version of artificial neural networks (ANN) which is predominantly used to extract the feature from the grid-like matrix dataset. For example, visual datasets like images or videos where data patterns play an extensive role. They power image search ser- vices, self-driving cars, automatic video classification systems, and more. Moreover, CNNs are not restricted to visual perception: they are also successful at other tasks, such as voice recognition or natural language processing (NLP); however, we will focus on visual applications of image recognition. During training, the CNN learns to minimize a loss function by adjusting its internal parameters (weights and biases) using optimization algorithms like gradient descent. This process of iteratively updating the network's parameters allows it to learn to accurately classify or recognize objects in images. CNNs have proven to be highly effective for a wide range of computer vision tasks, achieving state-of-the-art performance in tasks like image classification, object detection, and semantic segmentation.

Convolutional Neural Network consists of multiple layers like the input layer, Convolutional layer, Pooling layer, and fully connected layers. Figure 2 shows the different layers of Convolutional Neural Networks

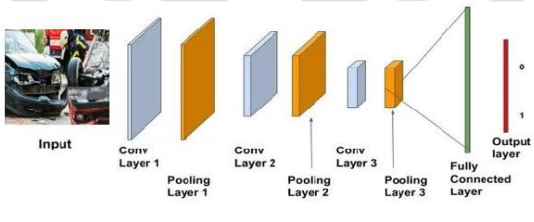

Fig 2: CNN Layers

- **Input Layer**: Receives raw video image data. It’s the layer in which we give input to our model. The number of neurons in this layer is equal to the total number of features in our data (number of pixels in the case of an image).
- **Convolutional Layers**: Extract features by applying filters and passing outputs to subsequent layers. Convolution layers consist of a set of learnable filters (or kernels) having small widths and heights and the same depth as that of input volume. This is the layer, which is used to extract the feature from the input dataset. It applies a set of learnable filters known as the kernels to the input images. The filters/kernels are smaller matrices usually 2×2, 3×3, or 5×5 shape. it slides over the input image data and computes the dot product between kernel weight and the corresponding input image patch. The Convolutional layer applies filters to the input image to extract features, the Pooling layer down samples the image to reduce computation, and the fully connected layer makes the final prediction. The network learns the optimal filters through backpropagation and gradient descent.
- **Pooling Layers**: Down sample feature maps for efficiency and focus. This layer is periodically inserted in the covnets and its main function is to reduce the size of volume which makes the computation fast reduces memory and also prevents overfitting. The pooling layer down samples the feature maps generated by the convolutional layer. It reduces the spatial dimensions (width and height) of the feature maps while preserving the most important information. Common pooling operations include max pooling and average pooling.
- **Fully Connected Layers**: Learn high-level relationships between features and make predictions. It takes the input from the previous layer and computes the final classification or regression task. After several convolutional and pooling layers, the resulting

feature maps are flattened into a single vector and fed into a fully connected layer. This layer connects every neuron in one layer to every neuron in the next layer, allowing the network to learn high-level features and make predictions based on the learned features.

- **Output Layer**: Produces final classification or prediction (e.g., object category probabilities). The output from the fully connected layers is then fed into a logistic function for classification tasks like sigmoid or softmax which converts the output of each class into the probability score of each class. The output layer produces the final predictions or classifications based on the features learned by the preceding layers. The number of neurons in the output layer depends on the task at hand. For example, in a classification task with multiple classes, there will be one neuron for each class, often followed by a softmax activation function to produce class probabilities.

V. RESULT AND DISCUSSION

We implemented a system to process and to detect any abnormal activity which will help to create better security and less human intervention. Thus it was possible to design a low resource consuming accident detection system that can compute on cheap hardware which can detect accidents and provide an alert message to the most proximate control room immediately.

Figure 3 shows the model training accuracy and the time required to complete the execution of an algorithm.

Fig. 3. Model Training for Accident detection system

Figure 4 shows an accident detection between two vehicles. And respectively the alert message will be sent on Gmail or text message. This image, shows that two objects are collided on each other.

Fig 4. Accident Detected in a system

Figure 5 shows an no accident detected between two vehicles. This image, shows that two objects are not collided on each other. This is a normal event.

Fig 5. Normal Activity Detected in a system

Figure 6 shows the alert module for the vehicle accident detection. When an accident occur between two vehciles then alert message is sent to the near by police station or the hospital.

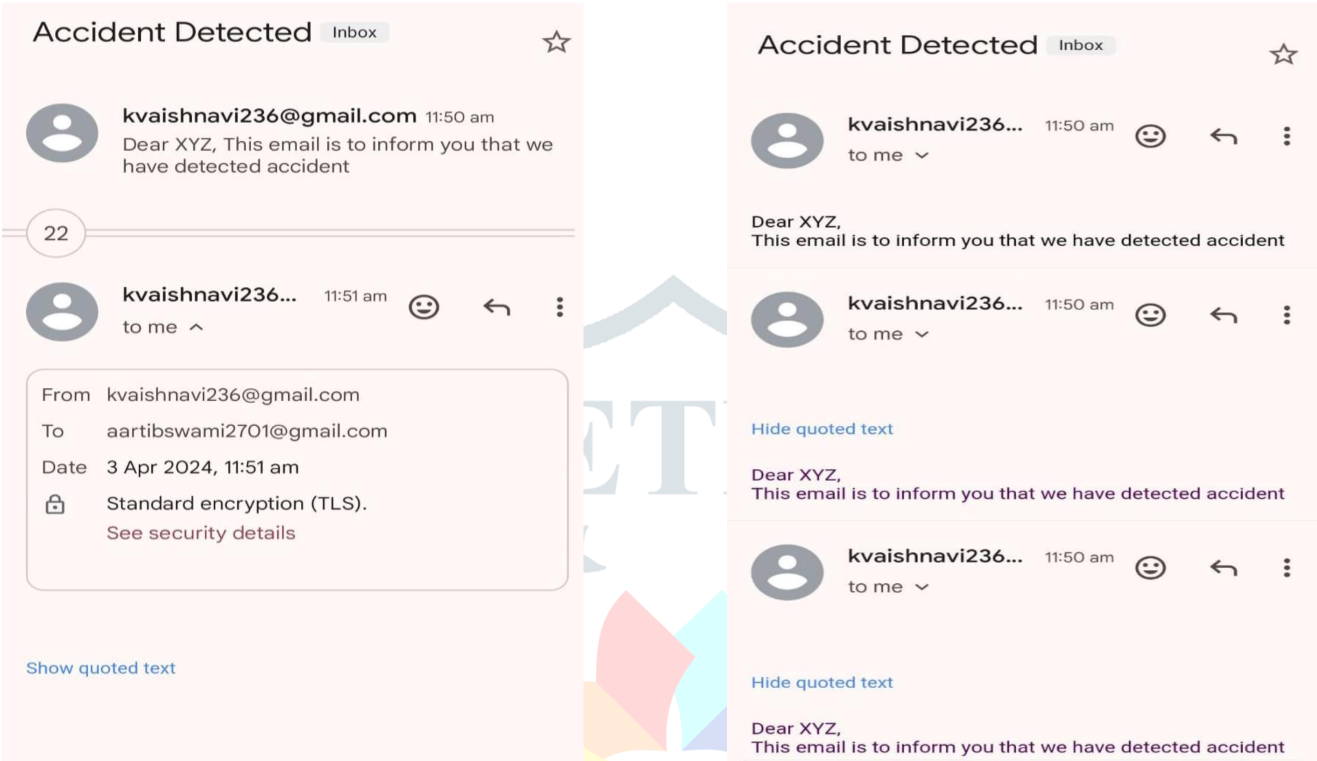

Fig .6. Alert module for Accident detection system

We have developed system which can effectively classify the frames into accident or non accident. The accident detection system using CNN has shown promising results. The model is able to accurately detect accidents in real time from video streams. The use of CNN for feature extraction for temporal modelling has proven effective in capturing both spatial and temporal information from the video frames. In terms of performance, the model achieved an accuracy of over 90% on the test set, indicating its ability to accurately detect accidents in videos. The model was also able to achieve a relatively low false-positive rate, indicating its robustness to different scenarios.

VI .Conclusion

We have successfully implemented accident detection using CNN. This model can be used in CCTV cameras, and it can alert the security person but in our model it only prints alert in the console. This project can be improved by calculating the distance between the camera and the vehicle and alert the driver if any vehicle is nearby One of the most frequent issues that humanity encounters on a daily basis is accidents, which result in the loss of both life and property. The suggested system offers a very practical and efficient solution to this issue. The capacity to track accidents as they occur is a feature of the suggested automobile accident detection system. The proposed system is significantly more cost-effective, foolproof, and accurate than its competitor thanks in large part to a model-based approach, unlike other systems in use that comprise expensive sensors and unnecessary hardware. Images have been used in the experimentation, testing and validation, and the results demonstrate that this method does indeed achieve higher sensitivity and accuracy; as a result, it is a viable option for implementing this system on the majority of the state and national highways in the country.

VII. Future Scope

Multi-Sensor Integration: Incorporating data from various sensors beyond just video, such as lidar, radar, and ultrasonic sensors, can enhance accident detection accuracy. Multi-sensor fusion can provide a more comprehensive understanding of the surroundings. Vehicle Autonomy: As autonomous vehicles become more prevalent, accident detection systems may need to adapt to identify accidents involving both autonomous and conventional vehicles. Integration with Emergency Services: Developing direct integration with emergency services, so the system can automatically alert and provide the exact accident location to first responders, potentially reducing response times. Energy Efficiency: Improving the energy efficiency of the system, especially if it relies on sensors or cameras, to minimize the impact on the vehicle's power consumption.

ACKNOWLEDGEMENT

We take this opportunity with great pleasure to express our deep sense of gratitude towards our guide Mr. Shrikant Shinde for his valuable guidance and incessant encouragement and co-operation extended to us during this project work. We would also like to thank Dr. S. D. Markande Principal, Sinhgad Institute of Technology and Science for his unflinching help, support and cooperation during the project work.

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