

Deep Learning Model for Accident Detection in Smart Cities using Computer Vision

Jidgnesh Sathishchandra Wani, Keerthi A., Kuriti Preethi Naidu, Shanthi M. B.

Department of CSE, CMR Institute of Technology, Bengaluru

jisa19cs@cmrit.ac.in, keea19cs@cmrit.ac.in, kupr19cs@cmrit.ac.in, shanthi.mb@cmrit.ac.in

Abstract: In recent years, the concept of smart cities has gained increasing attention, driven by the need to make urban environments safer, more sustainable, and more efficient. One of the key challenges in achieving this vision is the management of traffic, which is a major cause of accidents and delays in urban areas. Traditional methods of accident detection rely on manual reporting or sensor-based systems, which are often slow and imprecise. To address this challenge, researchers have proposed using computer vision techniques to automatically detect accidents in real-time. We have developed a deep learning model; CNN is capable of analyzing real-time video feeds from surveillance cameras installed in strategic locations throughout a city. In this paper, we will describe the proposed model in detail, including the architecture of the CNNs, the training process, and the real-time accident detection algorithm. Experimental observations have shown around 89% of validation accuracy in detecting the accidents based on the live video feed from cameras.

Keywords: smart cities, computer vision, deep-learning, sensor-based, video-feeds

I. Introduction

The concept of smart cities has given rise to the development of smart solutions for real time problems. Traditional methods of accident detection rely on manual reporting or sensor-based systems, which are often slow and imprecise. To address this challenge, researchers have proposed using computer vision techniques to automatically detect accidents in real-time. This approach has the potential to save lives and reduce injuries in accidents, as it provides emergency services with real-time information about the location and severity of the incident.

Every year, numerous road accidents occur all around the world, resulting in the loss of countless lives and serious injuries. Delayed response from emergency services often results in additional loss of life and property. Therefore, there is a pressing need for a system that can detect accidents in real-time and provide emergency services promptly. The current system for accident detection and emergency response is largely dependent on human intervention. It relies on individuals or passersby to alert authorities of an accident, which often leads to a delay in response time. In some cases, the severity of an accident can go unnoticed entirely, and no assistance is provided. Furthermore, emergency services are often unable to locate the exact

location of the accident, leading to further delays in reaching the scene. Therefore, there is a need for a system that can automate the process of accident detection and response. The system should be capable of detecting accidents in real-time, accurately identifying the location and severity of the accident, and automatically notifying the relevant authorities. This would ensure that emergency services are alerted immediately, reducing the response time and providing prompt assistance to those in need.

II. Related Study

The research study shows the use of Artificial Intelligence in detection of accidents for quick response in smart cities. Here is an overview of recent research on DL models for accident detection in Smart Cities. Y. Chen et al. [1], proposed a DL model for real-time accident detection in urban traffic scenes. The model employs a Faster R-CNN algorithm and ResNet-50 as a backbone network to detect and classify accident images into three categories: collision, fire, and smoke. Hang Shi et al. [2] have developed a YOLOv4 method for object detection and object tracking based on Kalman filter coupled with the Hungarian algorithm for association, and accident detection by trajectory conflict analysis. They have got an accuracy of 93.1%. Computer Vision Based

Approach to Detection and Classification of Traffic Incidents was employed by RazanSendi et al. [3]. The vehicle detection and tracking model assigned a distinct identification number (ID) to each vehicle and combined the YOLOv5 object detector with the DeepSORT tracker to detect and monitor the movements of the vehicles. The mean average precision (mAP) of this model was 99.2%. A human operator or emergency services would be notified in the event of an accident utilising a computer vision-based deep learning model for accident detection in smart cities.

III. System Design and Implementation

The proposed system aims to predict the accident and alert the nearest emergency services to provide timely first aid to the victim and potentially save their life. To achieve this goal, Deep Learning techniques based on Convolutional Neural Networks (CNN) will be used. The implementation of this system involves collecting a large dataset of accident images or videos, pre-processing the data, training the CNN model, and deploying it to detect accidents and alert emergency services. Fig. 1 shows the system architecture for the proposed system.

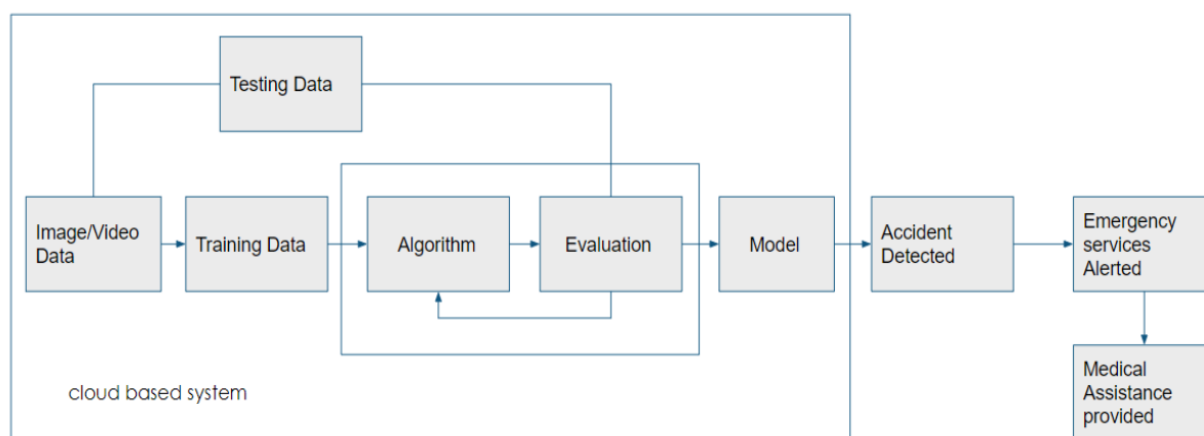


Fig. 1. System architecture for the proposed system.

The system architecture for accident detection using Convolutional Neural Networks (CNN) typically involves the following components.

A. Data Collection: A large dataset of images and/or videos of accident scenes needs to be collected. This dataset should include a variety of accidents, including different types of vehicles, different road conditions, and different degrees of damage.

B. Data Pre-processing: The collected data needs to be pre-processed to ensure that it is suitable for use with the CNN. This may involve tasks such as resizing images, normalizing pixel values, and separating the dataset into training, validation, and testing sets.

C. CNN Model Architecture: The CNN model architecture needs to be designed, which typically involves choosing the number and type of layers, the size of the filters, and the activation functions. The model should be designed to learn to

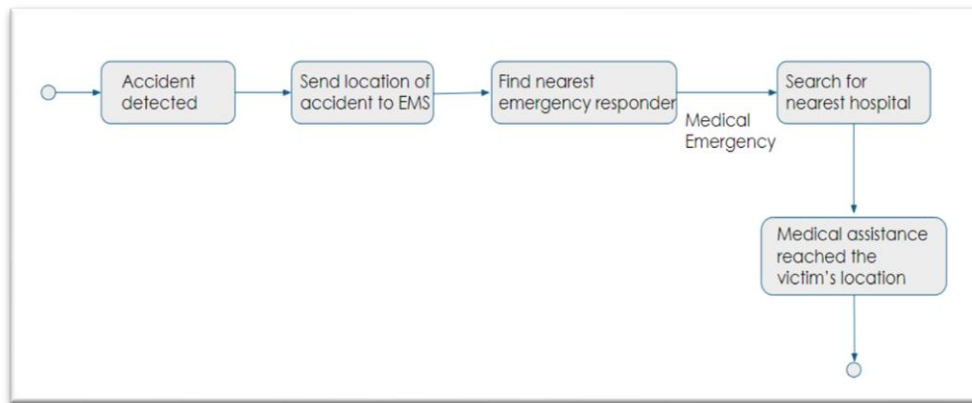
recognize the features that are indicative of an accident, such as damaged vehicles or debris on the road.

D. Model Training: The CNN model needs to be trained using the prepared dataset. This involves optimizing the model's weights and biases to learn to recognize the features that are indicative of an accident.

E. Model Evaluation: Once the model has been trained, it needs to be evaluated using a separate set of images and/or videos that were not used during training. This is to evaluate the model's performance on unseen data and ensure that it is able to generalize to new accident scenarios.

F. Deployment: Once the model has been tested and its performance is satisfactory, it will be deployed in a real-world scenario. It would be integrated into a traffic monitoring system that analyses live video feeds from traffic cameras to detect accidents and alert emergency services.

Fig. 2 Shows the Workflow Of The Proposed System.



The system receives input from cameras installed in the area that monitor traffic and detect accidents. It uses computer vision techniques, such as object detection and image segmentation, to identify accidents in the input data. Once an accident is detected, the system uses a CNN model trained on accident images to predict the type of accident, such as car crash or any other type of

accident. The system alerts the nearest police and hospital to provide timely first aid and potentially save the victim's life. The system tracks the victim's location and provides real-time updates to emergency services until they arrive on the scene. The graphs given in Fig.3 and Fig.4 shows the training loss versus training accuracy and validation loss versus validation accuracy.

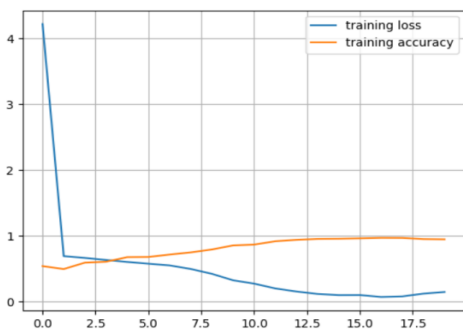


Fig.3 Training loss V/S Training accuracy

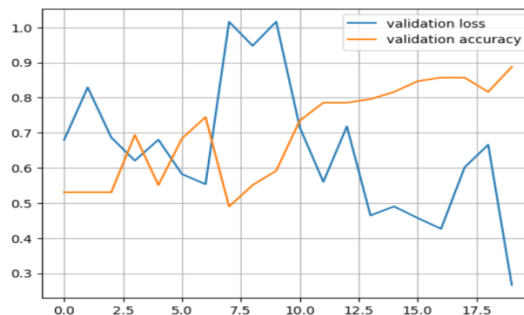


Fig.4 Validation Loss V/S Validation Accuracy

IV. Results And Discussion

When a photo is analyzed using a Convolutional Neural Network (CNN) algorithm for car detection, the algorithm will look for features in the image that are commonly associated with cars[6]. These features might include the shape of the car's body,

the size and position of its wheels, the presence of headlights or taillights, and other details that help distinguish cars from other objects in the image. It is shown in Fig. 5 in which car is detected and Fig. 6 in which accident is not detected.



Fig. 5 Car is detected.



Fig. 6 Accident is not detected

A video is divided into individual frames to identify if an accident has occurred. When a video is analyzed using a Convolutional Neural Network (CNN) algorithm for accident detection, the algorithm will look for patterns in the video frames that indicate the presence of an accident. These patterns might include sudden changes in the motion of objects in the video, the appearance of smoke or debris, or other visual cues that suggest a collision or other type of incident has occurred[14]. To detect accidents, the CNN algorithm will likely need to be trained on a large dataset of videos that include both accident and

non-accident scenarios, so that it can learn to distinguish between the two. The algorithm may also need to be programmed to recognize different types of accidents, such as vehicle collisions, pedestrian accidents, or fires.

Once the CNN algorithm has detected an accident in the photo, it can be used to trigger an alert or notification to a human operator or emergency services. The alert can include details such as the location of the accident, the number of vehicles involved, and any other relevant information that can assist in responding to the incident. Fig. 7, 8, 9 shows the different frames used.



Fig. 7 Frame 1



Fig. 8 Frame 2



Fig. 9 Frame 3

An alert message sent to emergency medical services during an accident is a communication that is sent to notify medical personnel of a serious incident or accident that requires

immediate medical attention[11]. The message is usually initiated by a witness to the accident or someone who has come across the scene of the accident. The alert message may include details

such as the location of the accident, the nature and severity of injuries sustained by the individuals involved, and any other relevant information that could assist medical personnel in providing timely and appropriate care. The message is usually sent to a centralized emergency medical services (EMS) dispatch center, which is responsible for coordinating the response to the accident. Upon receipt of the alert message, the EMS dispatch center will typically mobilize appropriate medical resources, such as ambulances, paramedics, and other first responders, to the location of the accident. The medical personnel will then assess the situation, provide any necessary medical treatment, and transport the injured individuals to the nearest hospital or medical facility.

III. Conclusion And Future Scope

In conclusion, the proposed system for reducing fatality in road traffic accidents utilizes CNN-based systems to analyze video footage in real-time and detect potential accidents. By automatically alerting emergency services, this system aims to facilitate a more rapid response and potentially save lives. The use of CNNs offers advantages such as improved accuracy and speed in accident detection compared to traditional methods. However, it is important to acknowledge that there are still limitations and challenges associated with this approach. One key challenge is the requirement for large datasets to effectively train the CNN models. Sufficient and diverse data is necessary to ensure that the system can accurately identify various types of accidents and distinguish them from false positives. Seamless communication and coordination between the accident detection system and emergency service providers need to be established to ensure timely response and appropriate allocation of resources. With further advancements in technology and improvements in data availability, these systems have the potential to enhance road safety and minimize the fatality rate associated with road traffic accidents. Continued research and development in this field are essential to overcome the existing limitations and maximize the effectiveness of such systems in real-world scenarios.

References:

- [1] Computer Vision based Traffic Monitoring and Analyzing from On Road Videos By T.M. Amir-Ul-Haque Bhuiyan, Mrinmoy Das & Md. Shamim Reza Sajib Bangladesh University of Business & Technology (BUBT).
- [2] Automatic Traffic Surveillance using Video Tracking Bhushan Nemade Department of Information Technology, Thakur College of Engineering and Technology. Mumbai 400101.
- [3] Accident Detection using Deep Learning: A Brief Survey Renu 1 , Durgesh Kumar Yadav 2* ,Iftisham Anjum 3 and Ankita 4 1 Assistant Professor, Department of Computer Science and Engineering, Greater Noida, Uttar Pradesh, India.
- [4] Vehicle Detection and Tracking for Traffic Surveillance Applications: A Review Paper Anshul Vishwakarma , Amit Khare.
- [5] Accident Detection and Emergency Alerting System for Road Safety Dilipkumar A. Borikar1* and Manoj B. Chandak2 1,2Shri Ramdeobaba College of Engineering and Management, Nagpur, Maharashtra, India.
- [6] Car crash detection using ensemble deep learning and multimodal data from dashboard cameras(Jae GyeongChoia1Chan WooKonga2GyeonghoKima3 SunghoonLim) Science Direct. Computer Vision-based Accident Detection in Traffic Surveillance IEEE.
- [7] Gowshika B, MadhuMitha, G,Jayashree,Vehicle accident detection system usingGPS, GSM modem, IRJET, 2019.
- [8] Sayanee Nanda, Harshada Joshi, Smitha Khairnar, An IOT Based Smart System for Accident Prevention and Detection,IEEE,2018.
- [9] Norsuzila Yaacob, AinnurEizaAzhar, Azita LailyYusofl, Suzi SerojaSarnin,Darmawaty Mohd Ali and Ammar Anuar, Real Time Wireless Accident Tracker using Mobile Phone,IEEE,2017.
- [10] Video-Based Traffic Data Collection System for Multiple Vehicle Types ShuGuang Li, Yu Hongkai, Zhang Jingru.
- [11] Almeida, T. A., Abreu, S., Silva, D. F., & Nunes, U. (2019). A survey on accident detection and management using wireless sensor networks and machine learning techniques. *Sensors*, 19(19), 4183.

- [12] Chou, J. S., Lai, T. H., & Huang, C. C. (2020). Review on real-time accident detection and warning systems for intelligent transportation systems. *Applied Sciences*, 10(6), 2087.
- [13] Zhang, G., Sun, W., Wang, H., & Sun, H. (2020). An intelligent emergency accident detection algorithm based on a deep learning model. *Sensors*, 20(3), 832.
- [14] Noh, H., Kim, D., Kim, D., & Park, J. (2019). Accident detection using deep learning-based video analysis for intelligent transportation systems. *Electronics*, 8(6), 674.
- [15] Xu, Y., Mao, Y., Zhang, L., Tang, M., & Wang, J. (2021). Review on accident detection and intelligent rescue systems based on computer vision. *Sensors*, 21(4), 1223.