Using Data Science for Vehicle Crash Detection and Warning Systems

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Abstract: ***Vehicle collision detection is an essential aspect of modern transportation systems that aims to reduce the frequency and severity of accidents on the roads. The primary goal of collision detection is to identify potential collisions between vehicles and other objects, including pedestrians, bicycles, and stationary obstacles. The detection process involves collecting and analyzing data from various sources, such as cameras to determine the speed, and trajectory of vehicles in real - time. Machine learning algorithms are often used to analyze this data and identify potential collision scenarios, alerting drivers or autonomous systems to take appropriate actions to avoid accidents. Effective collision detection systems can help reduce the number of fatalities and injuries on the roads, improving overall road safety and promoting sustainable transportation.***

Keywords: Accident Detection, YOLO, Dashboard Cameras, Bounding Box method, Machine Learning models, CNN, Neural Network

1. Introduction

Vehicles play a significant role in global transportation. Every day, there are numerous examples of traffic accidents worldwide. A car runs into another car, a pedestrian, an animal, or another stationary object like a structure or tree., to cause a traffic collision, sometimes referred to as an automobile accident, car crash. Traffic accidents frequently cause monetary costs to society and the environment, as well as physical damage injured, disabled, or killed parties. Road travel is the most dangerous situation that people regularly confront, but the number of fatalities from such incidents receives less public attention than that of other, less frequent types of accidents disaster

The Vehicle Collision Detection and Alert System using Deep Learning is one such solution that uses deep learning algorithms to detect and prevent vehicle collisions. This system employs object detection algorithms, such as You Only Look Once (YOLO), to identify the presence of vehicles on the road.

Vehicle collision detection and alert systems using data science are innovative technologies that aim to lessen the amount of road accidents by leveraging the power of data analytics and machine learning. These systems use a combination of sensors, cameras, and other data sources to collect and process real - time data on vehicle movements, speed, and proximity to other objects on the road. The data is then analyzed using advanced algorithms and statistical models to identify potential collision scenarios and alert drivers or autonomous systems to take appropriate actions to avoid accidents.

2. Literature Survey

Vehicle collision system for alerts and detection widely researched in recent years, with various approaches and techniques being proposed. One popular method for detecting objects in images and videos is using deep learning models.

In recent works it is suggested to use an ensemble deep learning model to detect car crashes. Dashboard camera video is used in an ensemble deep learning model. For video data, a base classifier based on GRU and CNN is created. For audio data, foundational classifiers built on GRU and CNN are created. The suggested system establishes cutting - edge categorization performance.

A similar work has been done using a deep learning - based model using SENet blocks in the ResNext architecture is suggested. The model's performance is contrasted with those of well - known deep learning models like ResNet50, VGG16, and VGG19. By using a substantially less percentage of the GTACrash simulated data for training and reaching a ROC - AUC of 0.91, the suggested model performs better than the baseline models currently in use. This lowers the computational burden.

There has been research done using YOLO for object and accident detection. Comprehensive a real - time, autonomous system for detecting accidents installed with the least amount of hardware. We suggest A deep learning model architecture called Mini - YOLO through information distillation for the detection step. Its accuracy is comparable to that of its counterpart.

You - Only - Look - Once (YOLO) with less computational overhead and model size. Regarding the MS - COCO dataset, Mini - YOLO outperforms every other detection

method in terms of runtime complexity, averaging on a low - end, astonishing 28 frames per second system. This results in a precision (AP) score of 34.2 on average.

–Estimation of Collision Priority on Traffic Videos using Deep Learning‖

In order to predict the collision priority of cars on the road, a brand - new heuristic unimodal approach built on the vision system is described in this work. The priorities are calculated from the viewpoint of an ego car, which might be fitted with either a completely autonomous vehicle or a vision - based driver assistance system. For input videos, the suggested qualitative technique works well, and by combining it with other quantitative interpretations of traffic data, a more reliable estimate can be obtained.

3. Plan of Action

We propose an automated, real - time system for beforehand detection of vehicle collisions during high traffic and intimate the concerned people using the application.

Our method uses a convolution neural network to classify, detect, and compute moving objects for photographs and recorded videos, and live videos in real - time. Using algorithms like YOLO, it will be able to detect the front as well as the rearview of the vehicle alert us beforehand.

The proposed system has the benefits of interpretability, high accuracy, a lightweight model, and quick processing.

Moreover, this system can be used in the cases of self - driving cars. Where it would analyse the collision possibility automatically and drive accordingly

It could be used in self - driving cars, traffic surveillance systems, traffic management, and automated driving applications.

4. Block Diagram

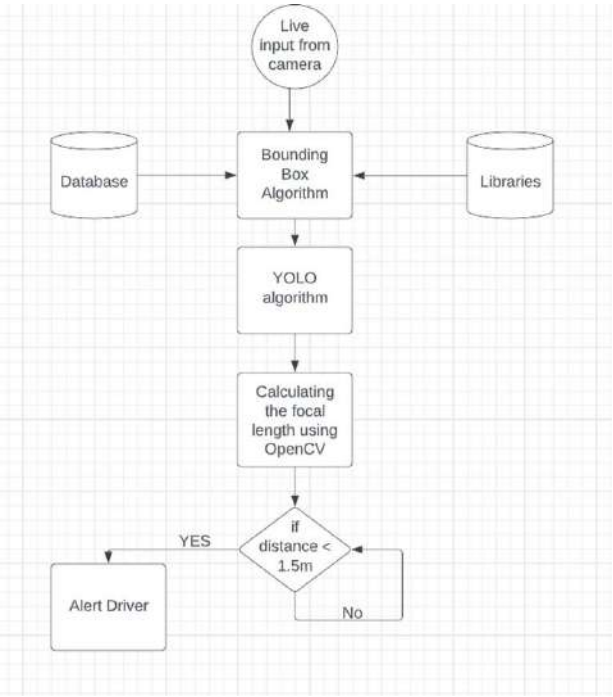

Figure 4.1: Block diagram for dashboard camera

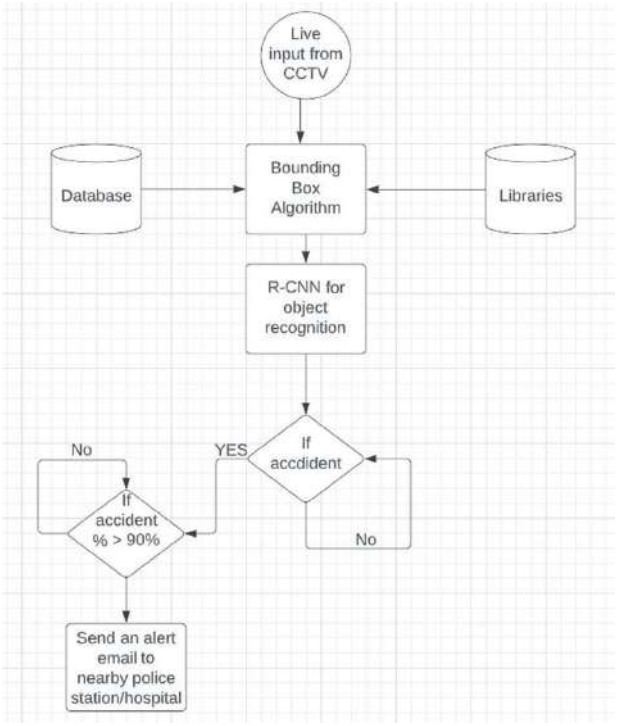

Figure 4.2: Block diagram for CCTV camera

5. Modules

5.1 Data Collection and Preprocessing

The process begins by setting up the environment and compiling the data.

Data collection is done by collecting the dataset from kaggle which contains roughly 700 images containing accident and no accident images.

After the data is collected, the quality datasets are labeled accordingly.

The data will be divided sent with a batch size of 100 and having height and width of 250.

5.2 Bounding Box Object Detection

A rectangular structure known as a bounding box is placed over an image and contains all of the essential details of the object it contains. It is one of the quickest and simplest ways to annotate pictures. The annotator boxes up the items in the photos in accordance with the project's requirements.

Its goal is to save computational resources by narrowing the scope of the search for the object's features. It assists in object detection as well as object classification.

Often, it involves drawing bounding boxes around the image's object. The box includes details on the object as well as coordinates, which indicate where it is in the image.

5.3 Accident Detection in CCTV camera using CNN

Accident detection in CCTV camera using CNN (Convolutional Neural Network) is an innovative approach to detecting accidents on the road using computer vision technology. The system involves the use of CCTV cameras positioned in strategic locations along the road network, which capture video footage of the surrounding area. The footage is then analyzed using a CNN, which is a type of deep learning algorithm designed for image and video analysis.

The CNN works by dividing the video footage into smaller, more manageable chunks known as "frames.‖ Each frame is then analyzed in detail, using a complex set of mathematical operations known as "convolutions" to identify features and patterns in the image.

Using these features and patterns, the CNN can detect potential accidents, such as collisions between vehicles, pedestrians, and other objects. Once an accident is detected, the system can generate an alert, notifying emergency services and other relevant parties of the accident's location and severity.

The use of CNNs in accident detection systems offers several benefits over traditional approaches. For example, by analyzing video footage in real - time, the system can quickly detect accidents and generate alerts, improving emergency response times and potentially saving lives. Additionally, the system can operate autonomously, eliminating the need for human intervention and reducing the risk of errors and delays.

Overall, the use of CNNs in accident detection systems represents a significant step forward in road safety and traffic management. By leveraging the power of computer vision and deep learning, these systems have the ability to greatly reduce the frequency of accidents and enhance emergency response times, saving countless lives and preventing injuries caused by road accidents.

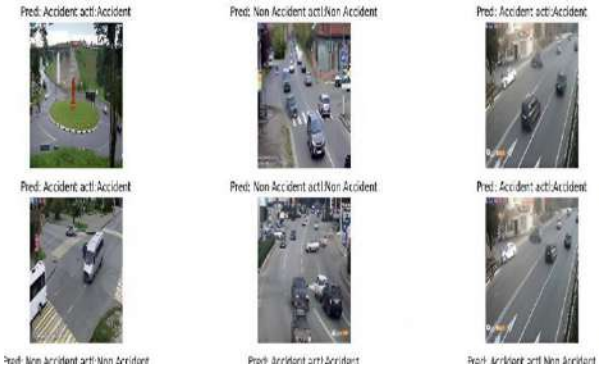

Figure 5.3.1: Output for R - CNN model

Layer (type)	Output Shape	Param #
batch_normalization (BatchNormalization)	(None, 250, 250, 3)	12
conv2d (Conv2D)	(None, 248, 248, 32)	896
max_pooling2d (MaxPooling2D)	(None, 124, 124, 32)	0
conv2d_1 (Conv2D)	(None, 122, 122, 64)	18496
max_pooling2d_1 (MaxPooling2D)	(None, 61, 61, 64)	0
conv2d_2 (Conv2D)	(None, 59, 59, 128)	73856
max_pooling2d_2 (MaxPooling2D)	(None, 29, 29, 128)	0
conv2d_3 (Conv2D)	(None, 27, 27, 256)	295168
max_pooling2d_3 (MaxPooling	(None, 13, 13, 256)	0

Figure 5.3.2: CNN Model

Figure 5.3.3: Accident detection

5.4 Object Detection using YOLO

A cutting - edge deep learning algorithm called YOLO (You Only Look Once) identify multiple objects in real - time video or image data. Because it can quickly and accurately identify objects in a single pass of an input image or video frame, the YOLO algorithm is well - liked. In order to identify potential objects, YOLO divides the input image into a grid of cells and creates bounding boxes around each cell. After training on a sizable dataset of labelled images, the algorithm uses regression techniques to predict the class and location of each object.

The YOLO algorithm is composed of two parts: a convolutional neural network (CNN) and a detection layer. The CNN extracts features from the input image, while the detection layer predicts for each object found in the image, bounding boxes and probabilities of the classes.

The benefits of using YOLO for object detection include its speed and accuracy, as well as its capacity to find numerous objects in a single pass. This makes it particularly useful for real - time uses include robotics, surveillance, and autonomous cars.

5.5 Calculating object distance using OpenCV

A free software library for computer vision and machine learning is called OpenCV. To accelerate the process the incorporation of artificial intelligence into products, OpenCV was utilised to create a infrastructure for applications involving computer visions. The capturing and analysis of images, as well as the use of technologies for object and face recognition —are the main areas of focus.

In our project, OpenCV assists with calculating the distance between a human and a car with the help of a dashboard camera which can be used in a running vehicle.

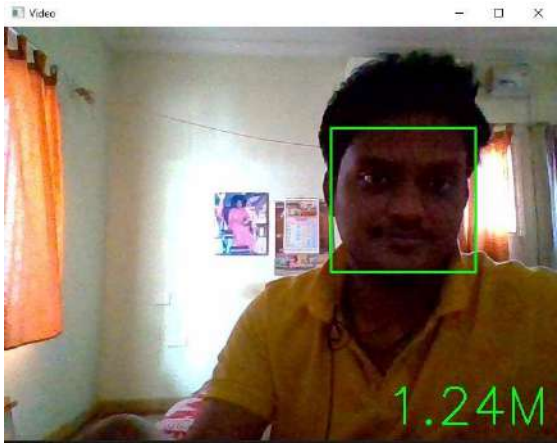

Figure 6.5.1: Output

6. Result

The main focus of this project was to detect accidents though CCTV cameras and videos. It has been successfully implemented by using CNN and the CNN model gave an accuracy of 84%. All the training data of this model is stored in an JSON file and the model need not be trained again. By using OpenCV and the trained JSON file we can detect accident and if the accident accuracy is more than 90% it prints ―Accident Occured‖ in the console. We have also achieved object detection using YOLO. There is an separate model which calculates the distance of the person (pedestrian) through camera.

7. Limitation and Future Work

Our CNN model has no alert system as it only prints in the console. The YOLO model cannot calculate the distance between the objects.

8. 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.

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