Traffic Management system using Deep Learning

Khushi Gupta[1], Trishul Shrivas[2], Siddharth Sharma[3], Uma Raj[4]

[1,2,3]UG Scholar, Electronics & Telecommunication Engineering Department, Shah and Anchor Kutchhi Engineering College, Mumbai, Mumbai University, Maharashtra, India
[4]Assistant Professor, Electronics & Telecommunication Engineering Department, Shah and Anchor Kutchhi Engineering College, Mumbai, Mumbai University, Maharashtra, India

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Abstract – *Traffic hazards are increasing, and road accidents are occurring on a regular basis, resulting in massive loss of life, property. This problem affects many aspects as modern society including economic development, traffic accidents, increase in greenhouse gas emission, time spent and health issues. The purpose of this project is to address this effect using machine learning based traffic management system (TMS). The major reason behind the accidents is the over speeding of the vehicles. People tend to be in hurry to reach their work-place or any event and sometimes knowingly cross the speed limit of the vehicle to reach on time and this leads to accidents. So, vehicle speed detection is also implemented in the project using image processing algorithms and OpenCV.*

Key Words: Traffic management, vehicle detection, YOLO, speed detection, Alexnet

1.INTRODUCTION

According to the requirements of large populations, government wants manage and develop the infrastructure in which smart / autonomous traffic management is key feature to smoothen the traffic [1]. How to manage the traffic automatically? Another situation is while in larger traffic how to cross the ambulance from that traffic. Considering such situations, the proposed traffic management system will dynamically change the signal based on traffic requirement [2]. This project uses some of the algorithms, datasets and mathematical calculations based on machine learning and python. The python programming language used can provide a platform to do some operations like object detection, image processing, and video processing etc. [3]. Vehicle speed is the most important risk factor for road accidents, injuries, severity, and fatalities. At any given time, half of drivers in urban areas exceed the speed limit. This causes accidents not only for the person speeding, but also for other people walking or driving nearby, endangering their lives [4]. The aim of this project is also to detect the speed of the vehicle which is the main cause of accidents. By extracting frames from the video and comparing the speed between two given points, it can be determined whether the vehicle is moving above the permissible limit or not. The system involves a traffic surveillance setup that can detect and track vehicles at night, along with a process for extracting the background and automatically detecting the vanishing point [4].

1.1 Problem Statement

To manage the traffic signal depending on the number of vehicles present so that unnecessary traffic can be reduced and will help people save time.

To decrease accident cases by detecting the vehicles crossing the speed limit.

2. BLOCK DIAGRAM

2.1 Traffic Management Module

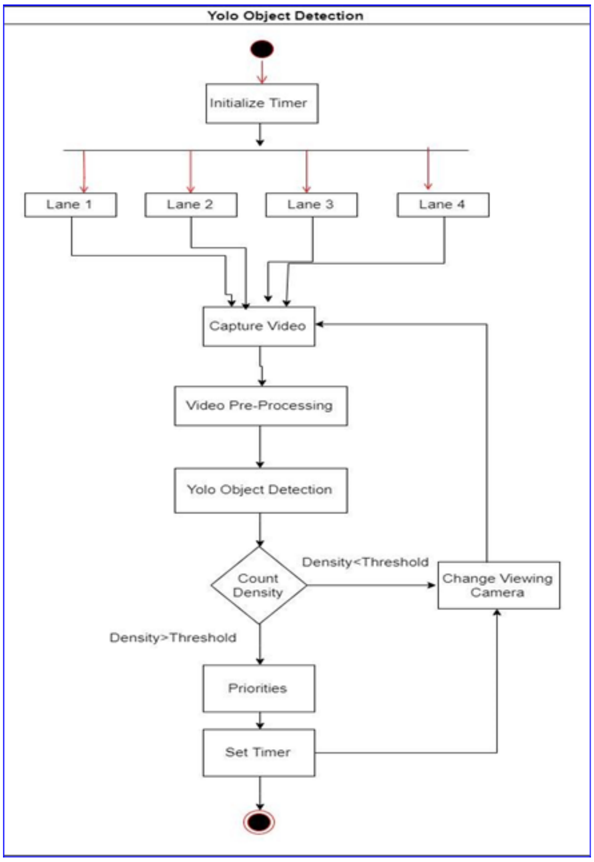

Fig -1: Block Diagram for Traffic Management

The four blocks labeled Lane1, Lane2, Lane3, and Lane4 are each monitoring a different lane of traffic. The processed video stream is then sent to the YOLO Object Detection. YOLO (You Only Look Once) is a popular object detection algorithm that uses deep neural networks to detect objects in real-time. The types of vehicles are recognized first and are classified into Transport Vehicles and Emergency Vehicle. The timer of the vehicle changes dynamically by monitoring the vehicle density of each lane. If the lane having less vehicles, then the timer of signal will be reduced. Also, if any type of emergency vehicle is present in any lane, then that lane will be prioritized first means that lane's signal will be green.

2.2 Speed Detection Module

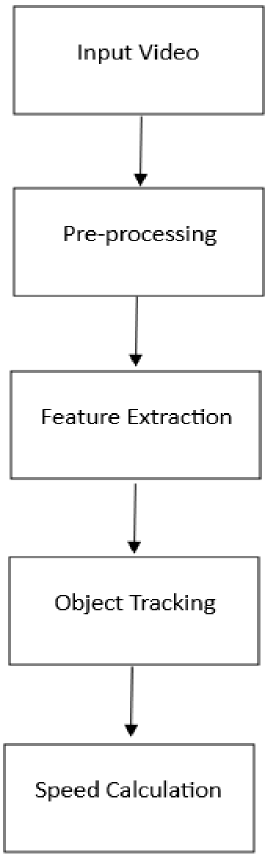

Fig -2: Block diagram for Speed detection

The system first captures an input image of a moving object, such as a car, using a camera or other imaging device. Input image is pre-processed to enhance its quality and reduce noise, using techniques such as noise filtering, contrast enhancement, and image resizing. The pre-processed image is analysed to extract relevant features, such as the object's size, shape, and position, as well as the background and road surface. The system tracks the object's movement over a series of frames to determine its speed, using techniques such as optical flow, Kalman filtering, and object segmentation. Based on the object's movement and distance travelled, the system calculates the object's speed, using techniques such as frame differencing and distance measurement.

3. SOFTWARE DESCRIPTION

3.1 Python 3

The python is an opensource programming language it means you can use this for your own purposes or free to use anywhere. This is currently in higher demand to IT industry. It's mostly used for the Machine learning to develop the websites, data science and software's etc. The python is very friendly to everyone. The python is almost similar to the C language only the difference in coding syntax. It is capable to perform various types of operations and it is used to build the machine learning, data analyze, complex statistical calculations.

The python has number of libraries that support performing varieties of task. Therefore, we are choosing this language for developing this project. If you want to use any kind of libraries you need to be installing in your desktop. “pip install” is the command to install any libraries of python.

Library Used:

1. NumPy: NumPy is a Python library used for working with arrays. It also has functions for working in domain of linear algebra, fourier transform, and matrices.

2. Keras: Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library.

3. Opencv: OpenCV (OpenSource Computer Vision Library) is an opensource computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products.

4. Pandas: Pandas is an opensource Python package that is most widely used for data science/data analysis and machine learning tasks. It is built on top of another package named Numpy, which provides support for multi- dimensional arrays.

3.2 Machine learning

The Machine learning (ML) is nothing but the artificial intelligence (AI). This is software application. It's having the ability to automatically learn and improve the performance without making a complex programming. “Machine learning focuses on the event of pc programs, which will access information and use it to find out for themselves.”.

"The ML permits analysis of huge quantities of data. Whereas it usually delivers faster, additional correct leads in order to spot profitable opportunities or dangerous risks, it additionally needs extra time and resources to coach it properly. Combining machine learning with AI and psychological feature technologies will build it even simpler in process large volumes of information".

3.3 Yolo Algorithm

In the field of object detection, the YOLO (You Only Look Once) algorithm is a deep learning-based approach. It operates by dividing an input image into a grid of cells, with each cell assessed for the likelihood of containing an object. Additionally, YOLO estimates the object's bounding box coordinates and class probabilities for each cell that contains an object.

3.4 Alexnet

AlexNet is a deep neural network that includes several convolutional and fully connected layers. The input to the network is a color image, and the output is a probability distribution of the classes of objects present in the image. One of the significant features of AlexNet is the use of Rectified Linear Unit (ReLU) Nonlinearity, which replaced the usual tanh or sigmoid activation functions. The use of ReLU nonlinearity allowed for faster training of deep Convolutional Neural Networks (CNNs) compared to saturating activation functions.

4. WORKING

4.1 Dynamic Traffic Management

The relevance of traffic management lies in its ability to improve traffic flow, reduce congestion, and enhance safety on roads. Traffic management systems use various technologies, including cameras, sensors, and communication networks, to monitor and control traffic on roads.

One of the key components of traffic management systems is object detection, which involves detecting and tracking vehicles, pedestrians, and other objects in the scene. Object detection is essential for various traffic management tasks, such as traffic flow analysis, intersection management, and incident detection.

The steps of working are as follows,

1.The camera sending the images to system in some intervals for processing.

2.This can be determined by the density of traffic from the roads and based on the calculations time of the traffic clear is changed which is shown in result.

3.The system decides which is signal is open for which time and it'll trigger the traffic signals.

Working solution can be explained in four simple steps:

1. Create a real-time image of each track.

2. Scan and determine the traffic density.

3. Enter this information into the time allocation module.

4. The output is the time intervals for each track, as required.

4.2 Ambulance Detection

Input to AlexNet

Fig -3: Ambulance detection

The above figure is the ambulance van detection as an emergency vehicle. With different types of ambulance vehicles images, the model has been trained. We are giving the input to AlexNet — it is an RGB image. This is called training with size 256*256. If the input image size isn't having 256*256, then the image is rescaled in such a way that is can be shorter in size of length 256 and cropped the image from center parts and converted into a size of 256*256. The image is trained with raw RGB pixel values. So, if the input image is grayscale, it is converted to an RGB image. 257 * 257 sized images were generated from 256 * 256 images by random cropping and fed to the first level of AlexNet.

4.3 Speed Detection

The relevance of speed detection lies in its ability to promote road safety by enforcing speed limits and reducing the risk of accidents. Speeding is a major contributing factor to road accidents, and speed detection systems are used by law enforcement agencies and transportation authorities to monitor and enforce speed limits on roads.

Image processing techniques for speed detection typically involve three main steps:

1. Detection: In the first step, the image processing algorithm detects the vehicles in the image and separates them from the background. This can be done using techniques such as background subtraction, edge detection, and object detection algorithms.

2. Tracking: Once the vehicles have been detected, the algorithm tracks their movements across multiple frames to estimate their speed. This is done by measuring the distance traveled by the vehicle between two or more frames and dividing it by the time elapsed between those frames.

3. Estimation: Finally, the algorithm uses the speed estimates to determine whether the vehicle is exceeding the speed limit. This can be done by comparing the estimated speed to the posted speed limit or by using a threshold value above which the vehicle is considered to be speeding.

Video is a sequence of consecutive image frames Video frames are processed using image processing techniques to extract background and foreground information. The background information includes stationary objects, weather conditions and time of day, while the foreground information includes moving objects like vehicles and pedestrians. The algorithm uses gray-scale images of both input and template images and matches the template image with each individual block of the input image using a correlation function with a matching factor. If a block matches the template, the algorithm retrieves information about the matched block's coordinates, area, and centroid value. The distance travelled by the vehicle is calculated using the centroid coordinates of the two most matched blocks, and the time taken by the vehicle to travel that distance is notified by the CCTV camera. The speed of the vehicle is then calculated using mathematical concepts of speed, time and distance.

5. RESULTS

The figure 4 shows the four lanes. Lanes are made from PAGE software. Traffic video of each lane will be played. The model will monitor the density of vehicles on each lane.

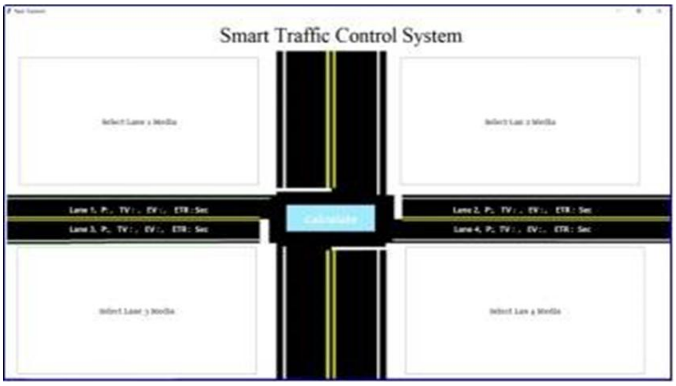

Fig -4: Dynamic Traffic control system

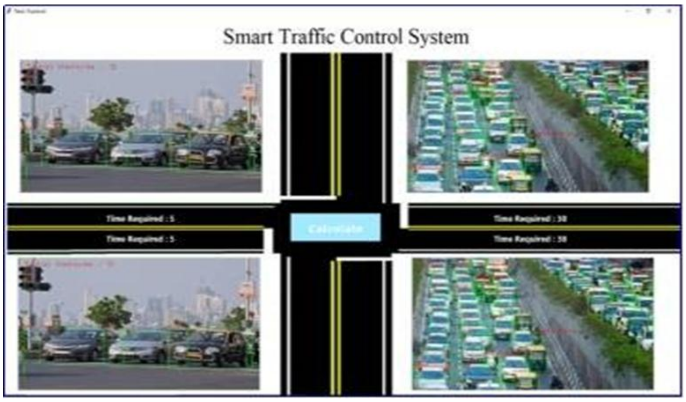

Fig -5: Camera view from all sides

As we can see the model monitors the lane and calculates the vehicle on each lane. This is done by the YOLO algorithm. Here in this project, YOLO algorithm detects the vehicles and classifies them into different types of vehicles such as Bikes, Cars, Buses, Trucks, etc.

Fig -6: Emergency vehicle detection

In the above fig. the ambulance is detected which is an emergency vehicle. So, the timer of signal is decreased automatically by detecting the ambulance. This done by using the AlexNet model. AlexNet model is trained with large number of images of different emergency vehicles. One of them is Ambulance.

```
[INFO] loading model...
[INFO] warming up camera...
[('A', 'B'), ('B', 'C'), ('C', 'D')]
[INFO] Speed of the vehicle that just passed is: 22.71 MPH
[('A', 'B'), ('B', 'C'), ('C', 'D')]
[INFO] Speed of the vehicle that just passed is: 13.81 MPH
[('A', 'B'), ('B', 'C'), ('C', 'D')]
[INFO] Speed of the vehicle that just passed is: 13.18 MPH
[('A', 'B'), ('B', 'C'), ('C', 'D')]
[INFO] Speed of the vehicle that just passed is: 13.12 MPH
[('A', 'B'), ('B', 'C'), ('C', 'D')]
[INFO] Speed of the vehicle that just passed is: 15.05 MPH
[INFO] elapsed time: 31.68
[INFO] approx. FPS: 22.22
[INFO] cleaning up...
```

Fig -7: Speed detection of vehicles

The speed detection code uses OpenCV and a pre-trained deep learning model to estimate the speed of vehicles on a road. The camera used to capture the footage must be aimed perpendicularly to the road. The code then collects timestamps of a vehicle at four waypoints, A, B, C, and D, and calculates the speed of the vehicle by dividing the distance traveled between each pair of waypoints by the time it takes the vehicle to travel that distance. The speeds calculated for each pair of waypoints are then averaged together and converted from miles per second to kilometers per hour and miles per hour. Finally, the code displays the speed of the vehicle that just passed each time it detects a vehicle, as well as the elapsed time and the approximate frames per second rate.

6. CONCLUSIONS

In this way we are developing a very smart traffic control system which can be able to detect and monitor the traffic. It can take decision according to the density of traffic. The proposed work guarantees that it will give an efficient and dynamic management of traffic considering emergency vehicles. The speed detection system implemented can help reduce accidents and hence save lives.

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