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Curbing Traffic Rule Violation Using Machine Vision

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ABSTRACT
According to a 2017 report of the Bureau of Police Research there are 20 crore registered vehicles for 72,000 traffic police. Though the number of traffic police have not changed much the number of vehicles has gone up to nearly 30 crore in 2022. Many drivers know that the probability of getting caught is very less. So, traffic rules like speed suggestions are taken more as a suggestion than a rule to be followed. This leads to many road accidents. The National Crime Record Bureau data on the accidental deaths in India shows the number has increased from 3,54,796 in 2020 to 4,03,116 in 2021.the fatalities have increased by 16.8 percent. The Cause-wise analysis reveals that most of the road accidents were due to over speeding accounting for 2,40,828 out of 4,03,116 cases (59.7%) causing 87,050 deaths and injuring 2,28,274 people. This project aims to reduce these over speeding violations by processing the CCTV camera footage to identify the violators and warn them and to fine the repeat violators. With the ever-increasing number CCTV cameras being installed across India and knowing that they are constantly monitored by the authorities will push the drivers to follow the rules more strictly
Keywords— YOLO, Image Processing, Open CV

1. Introduction
It is known that India is a Populated country and has a total number vehicle count of nearly 30 crore units in 2022. People prefer roadways as their preferred mode for transport. The major traffic rule violations which cause death threats are OVER-SPEEDING. Rules are imposed on speed limits, it's not only to avoid accidents. In protected zones such as schools, Hospitals, Forest zones speed should be in the limit. For example, in Coimbatore's Tiruchirappalli Road Fly-over speed limit is 30 Kmph on the down ramp. While the earlier speed limit was 40 Kmph but the Motorists were speeding up to 60 Kmph – 80 Kmph. According to the Times of India news report on 24th June 2022, a man killed after his motorcycle hit the wall of the fly-over. While the traffic police placed two barricades on the fly-over that didn't help prevent another fatal accident. This project aims to overcome Traffic Rule Violation with a Solution which uses the existing CCTV Cameras, to detect the traffic violation and penalize them on the spot. This project also helps the Government avoid the death rates due to over speeding and detect the person who violated the Traffic Rules.

2. Experimental Methods or Methodology
DATA- COLLECTION
Collecting images and videos of different kind of vehicles that will be converted to images and later used to train the neural network. The accuracy of the neural network increases as the size and variety of the data-set increases. The collected data is uploaded to Robo-flow website. We have collected more than 6000 images for this project. These collected images are then uploaded to Robo-flow website.

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ANNOTATE AND CLASSIFY

Now that we have the images, we decide on what are the objects the neural network will detect and what will the label given to the identified object. Once we finalize then boxes were drawn around the object and annotated it with its label. Multiple objects in the same picture can also be annotated here. This is done to all the images we have uploaded. The Dataset will group these images in the basis of classified annotation.

PREPROCESSING AND GENERATION OF DATASET

The pre-processing and augment the dataset was done. Pre-processing may include resizing, changing the contrast of the images, etc. Augmentation will improve the detection accuracy by carrying functions like rotation and distortion to improve the quality of the data set.

TRAINING OF NEURAL NETWORK

The YOLO v5 model of neural network which is built using Pytorch [2] was used. YOLO stands for You Only Look Once to the fact that it moves in classifies the object in one iteration of forward action throughout the network. YOLO v5 first divides the object on a square number of grids. Every grid cell will calculate a vector which along with the image. Excluding the introduction and conclusion, this paper contains three sections wherein the first section i.e. Method, Experimentation and Simulation, results.

Vector = [Pc, Bx, By, Bw, Bh, C1]

Pc = probability of the class (If an object is present in the box) one hot vector of all classes.

Bx = x coordinate of object center

By = Y coordinate of object center

Bw = Width of the bounding box

Bh = height of the bounding box

C1 = probability of class 1 given there is an object

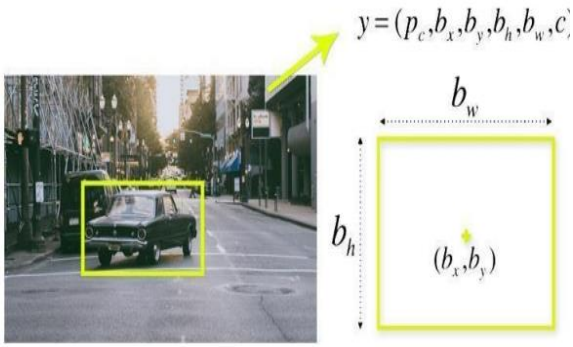

Fig 1. shows Vector of each image is calculated and along with the image is converted to YAML and TXT format which is used to train the neural network

OBJECT DETECTION AND CLASSIFICATION USING YOLO V5 MODEL

The input is formatted by the 5*5 input grid and then it is applied to the class probability map based on the training set it is compared and to the final detection.

To detect the object, classify it and to find its boundaries, first the image is divided into (19X19) grid. Every grid cell will predict bounding boxes and their confidence value.

Each bounding value will have a score, where

score = pc * probability of class vector (probability ofclass vector = [c1 c2 ...]T

class = argmax {score elements}

A Threshold value of score is set to reduce the number of bounding boxes.

For multiple detection of the same box we use IOU metrics.

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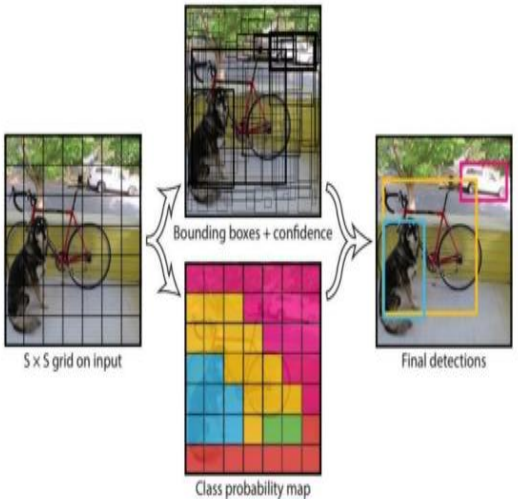

Fig 2. shows the image flow of input image to the final detection

$$IOU = \frac{\text{area of overlap}}{\text{area of union}} =$$

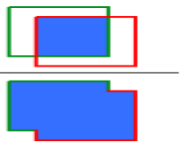

Fig 3. Intersection over union (IOU) describes how boxes overlap. YOLO uses IOU to provide an output box that surrounds the objects perfectly

This value is multiplied with the score of bounding boxes and the one with the highest is used and the rest are removed. This is done to make sure same object is not detected multiple times by the algorithm. This is how Yolov5 classifies the object.

NUMBER-PLATE DETECTION

Since it also get the boundary values with the YOLO detection the boundary box is cropped and saved in a new class created. Another detection of number plate is done on this picture which identifies the number plate. EASY-OCR package used to read the number plate snip and the value is stored in the class.

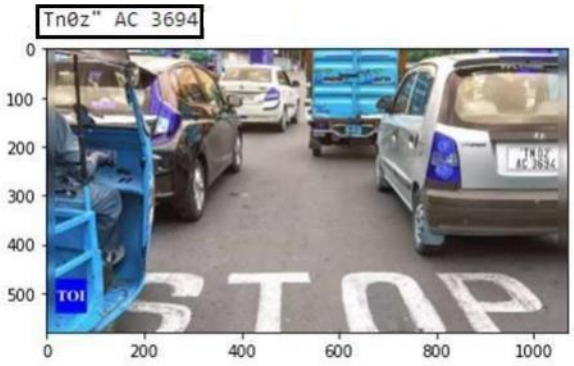

Fig 4. was captured at the location of signal. The colour converted image from RGB to BGR and the number plate details "TN 02 AC 3694"is shown above. For various location the program was tested for its efficiency. Number plate detection tends to be an extremely challenging subfield of computer vision, due to the vast diversity and assortment of license plate types across states and countries.

License plate recognition systems are further complicated by:

- Dynamic lighting conditions including reflections, shadows, and blurring
- Fast-moving vehicles
- Obstructions

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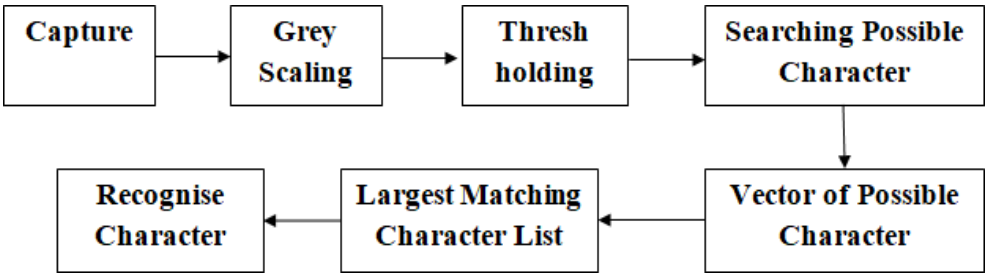

The data sets under various conditions are need to be trained to get a reliable output. The data set of vehicles were annotated with various types of vehicles in India like bus, car, motorcycle, truck, mini-truck. Data were took under dynamic conditions of weather in day-light, night, early morning, evening and rainy days.

ALGORITHM FOR SPEED DETECTION

Step 1: Fix two lines L1 and L2 in the Video. Calculate the distance D1 between them.
Step 2: Detect vehicles in the Video and start tracking them across the video.
Step 3: When the vehicle meets the line L1. Note the time as T1.
Step 4: When the vehicle reaches L2 note the time as T2.
Step 5: Calculate the apparent speed by the formula apparent speed = D1/(T2 - T1) .
Step 6: Multiply the calibration ratio to convert the apparent speed to real speed .
Step 7: Compare the vehicles real speed to the set threshold value. If the speed is greater than threshold print the vehicle tracking ID, their speed along with the warning that they are over speeding, else the track detecting the vehicle is deleted.

Deep SORT ALGORITHM

After the detection of the object, The Kalman Filter is employed to predict the object's position on the next frame. This is done by feeding the previous state and the object features as input to the filter. For each unique object or detection, a track is created that saves the position of the car at the sampling point of time. These detections are always cross referenced with a Siamese neural network that is employed to check if the object is same as the old one. This comes in handy in cases where the tracking object is hidden by a foreground object for a frame or two, the ones without the check will assign a new id and a track considering it as a new object. This problem is avoided while using the deep sort. as it cross references the new detection using a pre trained Siamese network.

3.Results and Discussion

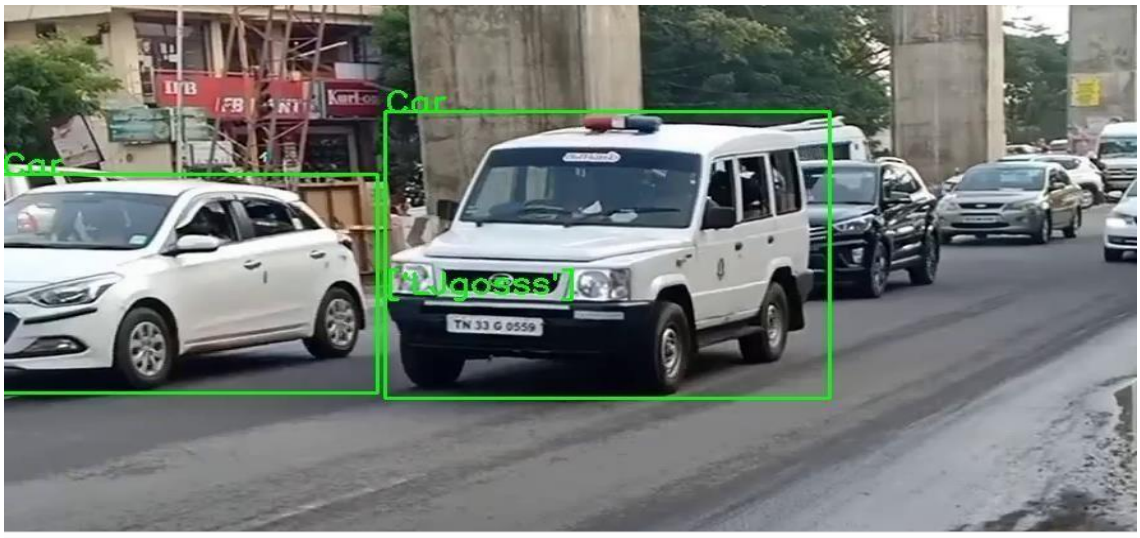

Fig 5. number plate detection and classification output of sample taken at CMC Signal, Coimbatore

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Fig 5. shows the output of implementation of both number plate detection and classification algorithm in a single input taken at CMC signal, Coimbatore. Hence both the algorithms are combined under a single program. Here the accuracy of number plate details was bad and hence the OCR technique was improvised and the result is shown in Fig.6

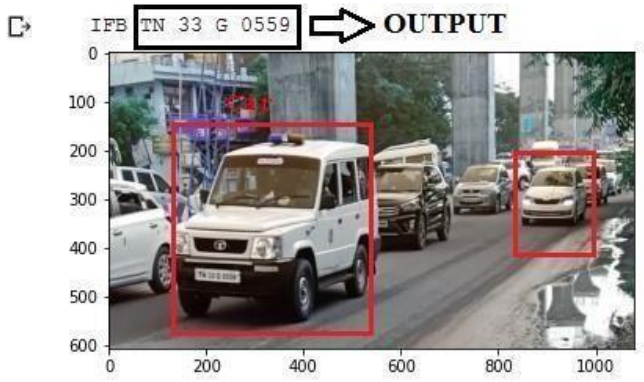

Fig 6. Result on an improved OCR

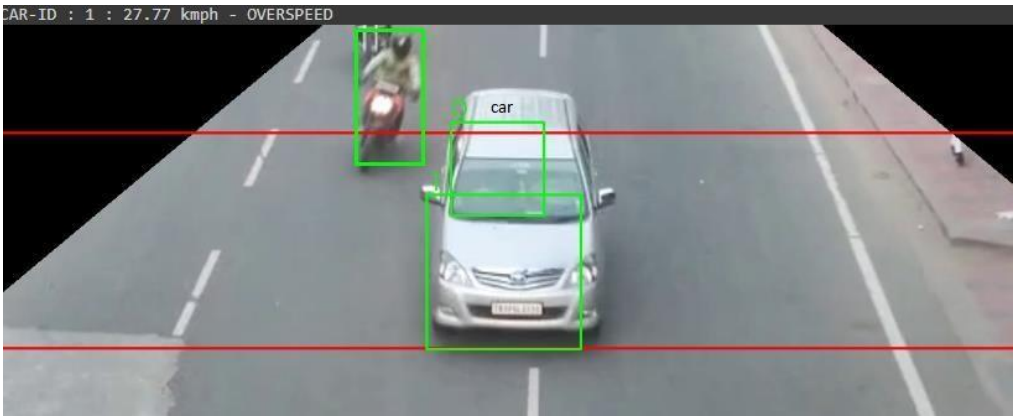

Fig 7. Identification and Tracking of over speeding Car

Fig 7. shows the speed of the over speeding vehicle from the footage taken on the PSG College bridge's live CCTV Footage. The Speed limit was set to 20 kmph in theprogram and hence the Car which was identified using trained Robo-flow model and the number plate was extracted.

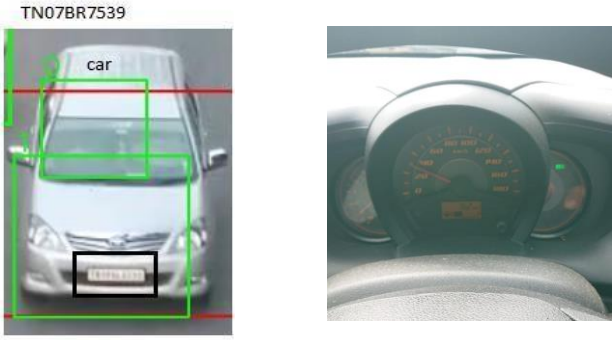

Fig 8. Number plate of over speeding vehicle

Fig 8. shows the extracted number plate details of the over speeding vehicle taken from the CCTV footage**,** which is useful in imposing fine on the vehicle. Thus, all the algorithms were implemented in the speed detection program and the number plate of traffic rule violated (over speeding) vehicle was identified.

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CONCLUSION

The Number plate was detected and the details were collected from m Parivahan App by Detection algorithm using Open CV and Python Tool. The Classification of different vehicles like Auto-rickshaw, Bike, Car, Motorcycle and Truck were classified using YOLO V5 algorithm and the datasets were trained using Robo-flow. The real-time datasets were collected from different parts of Coimbatore and trained using Robo-flow. Thus using the Over Speed detection program the vehicle which violated the over speeding was tracked, number plate was extracted and the fine was imposed on the vehicle. The accuracy of classifying and detection was enhanced by increasing the training data .Hence the main aim of this project of detection of Over speeding vehicle was identified and fine was imposed.

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