A PROJECT REPORT ON

TRAFFIC RULES VIOLATION DETECTION USING ARTIFICIAL INTELLIGENCE

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CERTIFICATE

This is to certify that the project report entitled

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is a bonafide work carried out by them under the supervision of Prof. N.R. Sonawane and it is approved for the partial fulfilment of the requirement of Savitribai Phule Pune University for the award of the Degree of Bachelor of Engineering (Information Technology)

This project report has not been earlier submitted to any other Institute or University for the award of any degree or diploma.

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ABSTRACT

Road is one of the most important modes of transport in India and it has the largest network of roads in the world. But with large population, lack of man power and technology, road accidents have become a part and parcel of life. Most of the times, the accidents are caused due to the violation of traffic rules by the people. So, to ensure safety of people on the streets of India, pinpointing the traffic rule violators is a highly prudent job but also difficult because of numerous obstacles. In this paper, we propose a framework of a system for detection of violation of some of the traffic rules like wrong way using centroid tracking algorithm, two-wheeler riders wearing helmets or not. After the violators are detected, the license plate of those vehicles is detected and the text information is extracted using OCR, and the violators are notified. Thus, a complete autonomous system will help to strengthen the traffic management system.

1. INTRODUCTION

1.1 Background

India is the second-most populous country in the whole world with a population of more than 135 crore people in the country and that number is increasing by the minute. It is also the country with the most number of two-wheeler owners in the world. With such a huge population and diverse nature of the country, controlling the logistics and transportation is a living nightmare for the authorities.

Developing Country with a high population such as India, has a vast population which uses the high number of vehicles for the transit from one place to another, and therefore lots of vehicles are required and which causes lots of traffic on the road. Heavy traffic congestion leads to an increase in the number of violations and hence it is difficult to manage and control traffic. To compelling people to follow traffic rules, it is necessary to give a quick response to violations done by them. Thus many technologies are improved in response to their action. These quick actions may be useful for controlling traffic rules.

Violations in traffic laws are very common in a highly populated country like India. The conditions are even worse in metro cities like Delhi, Mumbai Bangalore and Pune. The accidents associated with these violations cause a huge loss to life and property. Not wearing helmets and driving vehicles in wrong ways are major rules which are not followed and thus cause many deaths and serious injuries to self and others. Lack of required infrastructure and lack of following rules is the motive to develop this system.

1.2 Relevance

There are many vehicular accidents that happen across the country, India. It will help there is a system in place that monitors the people that are breaking the rules and Help us penalize such rule breakers which in turn will help in reducing the accidents that happen due to such reasons.

It is this need that brought about the idea of making such a system. A penalty System will help in making people follow the rules.

1.3 Project Undertaken

The main objective of the project is to make people follow traffic rules by developing a system which can detect violations. In this project, two main traffic problems which include ‘driving two wheelers without helmet’ and ‘driving a vehicle in wrong way’ are covered.

The Wrong Way is checked as follows in three steps:

- In the first stage, every vehicle in the video frame is detected using the YOLO object detection algorithm and a bounding box is generated for each detected vehicle.

- The bounding boxes are fed to the centroid based moving object tracking algorithm. The algorithm tracks each vehicle independently in the entire video frame.

- Finally, the direction of the vehicle is determined by calculating its centroid’s distance from the origin in each frame and detect whether it moves in the wrong direction or not. If the vehicle is on the wrong side, then the system will capture an image of the vehicle

The system first uses YOLO algorithm for identifying vehicles from the input video. It also generates bounding boxes for each vehicle and differentiates the vehicle into two classes namely two-wheeler and car. Two wheelers are checked for helmet and wrong way while Cars are checked for wrong way. Helmet checking is done using YOLO algorithm.

After detecting violations, the number plate of vehicles is detected and character recognition is performed on the number plate.

1.4 Organization of Project Report

First Chapter of the report contains introduction to the project undertaken. It gives background and relevance about the topic i.e. regarding traffic rules violation. This chapter gives basic idea , aim, objective of the project.

Second chapter contains background about the implementation of the project. It contains information about YOLO algorithm which is used for object detection . This chapter also has literature survey of the project which gives information regarding work related to the traffic rules violation detection and number plate detection.

Third chapter is specification. It gives technical specifications required for implementation of the project.

Fourth Chapter is Design. This chapter provides details regarding implementation of the project through various UML diagrams like Activity Diagram , Sequence Diagram, Use Case Diagram. This section has Architecture Diagram and DFD Diagrams as well with which user can get idea about the system.

Fifth chapter is about implemetaion of the project. Flowchart of the system is included in this chapter. It also gives detailed information about the implementation and various algorithms used. This section is all about working of the system.

Sixth chapter is Experimental Results. This chapter contains output of the system as well as test cases performed on the system. The Seventh Chapter is regarding References.

2. LITRATURE SURVEY

The existing system in India used for detection of violation and punishing the violators works manually. The CCTVs on the streets record the traffic all day long. These real time footages are then monitored by the traffic police team in the control room and when they detect any violation, the license plate is noted and a screenshot is captured as a proof. Then the police send a message to the violator thus charging them a fine. Hence, we propose an automation of this process.

For vehicle detection, Prem Kumar Bhaskar [1] had proposed to develop an algorithm using Gaussian mixture model and blob detection methods. However, the drawback in this method was that the blob detection required successive image frames for detection. Kunal Dahiya [2] proposed an approach that first detects all objects from surveillance videos using background subtraction and object segmentation. Then features were extracted using methods like Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG), Scale Invariant Feature Transform (SIFT) and a binary SVM classifier to classify the objects. But the background subtraction was affected by the shadow of the vehicle itself.

For wrong-way detection, computer vision technology is being used in many systems. M. J. Caruso [3] proposed a sensor-based method which used magnetic sensor to detect the direction of the vehicle. But the drawback in this system was that the magnetic field varied due to other reasons too, thus not giving satisfactory results. The framework proposed in [4] used motion pattern-based method using optical flow measurement. It used optical flowcalculation to detection the direction of the vehicle and compare it with modelled lane direction. But this method faced problems because of occlusion. Improved optical flow estimation was used by H. H. Nguyen [5]. He used background subtraction and Lucas-Kanade method to detect wrong-way vehicles. But this system proved to be a failure because in different light conditions, the background subtraction method was highly affected by the shadow of the vehicle itself.

For detecting helmet, some systems used the methods like LBP, HOG and SIFT. But these methods took a lot of time for implementing and made the process slow. J. Chiverton [6] proposed an approach by considering the reflective properties of a material. The approximate region of the head of the rider was isolated, which was used as a feature that was derived from histogram operations applied to the region. It was observed that the top of the heads was brighter than the bottom of the helmet. The drawback with this approach was that the methodology was based on the concept of reflection which may vary for different surfaces and also ample amount of light should be present to have a significant difference between upper and lower surfaces for detection. Gomathi [7] proposed an approach for detection of helmet using IR sensors, Arduino microcontroller, power supply and RF transmitter.

However, this involved lot of hardware which required a lot of maintenance which made it costly. The possibility of hardware being damaged was also high. After detecting the vehicles using object detection and classifying them according to the violations, the license plate of the corresponding vehicle has to be recognized. Amey Narkhede [8] proposed an approach using Edge detection to find the boundaries of the objects, Hough transformation for feature extraction and line detection and lastly K-nearest neighbour to recognize the segmented characters. Many other systems also used

Canny edge detection but the drawback in using this method was that it detected all the edges in the image and it became computationally expensive to select only those edges which actually belonged to the license plate.

3.TECHNICAL SPECIFICATION

We have used YOLOv3 algorithm for vehicle detection and license plate detection. Centroid tracking for tracking of vehicle. Keras OCR for recognition of license plate.

3.1 YOLO

You Only Look Once commonly abbreviated as YOLO is a very fast, accurate algorithm used for object detection. It uses anchor box for prediction.

3.1.1 Anchor Boxes

It might make sense to predict the width and the height of the bounding box, but in practice, that leads to unstable gradients during training. Instead, most of the modern object detectors predict log-space transforms, or simply offsets to pre-defined default bounding boxes called **anchors**. Then, these transforms are applied to the anchor boxes to obtain the prediction.

Anchor boxes are pre-defined boxes that have an aspect ratio set. These aspect ratios are defined beforehand. These anchor boxes anchor to the grid cells and share the same centroid. YOLO v3 uses **3 anchor boxes for every detection scale**, which makes it a total of **9 anchor boxes.** The bounding box responsible for detecting the object will be the one whose anchor has the highest IoU with the ground truth box.

3.1.2 Non-Maximum Suppression

There is a chance that after the single forward pass, the output predicted would have multiple bounding boxes for the same object since the centroid would be the same, but we only need one bounding box which is best suited for all the.

For this, A method called non-maxim suppression (NMS) which basically cleans up after these detections. We can define a certain threshold that would act as a constraint for this NMS method where it would ignore all the other bounding boxes whose confidence is below the threshold mentioned, thus eliminating a few.

But this wouldn’t eliminate all, so the next step in the NMS would be implemented, i.e. to arrange all the confidences of the bounding boxes in descending order and choose the one with the highest score as the most appropriate one for the object. Then we find all the other boxes with high Intersection over union (IOU) with the bounding box with maximum confidence and eliminate all those as well.

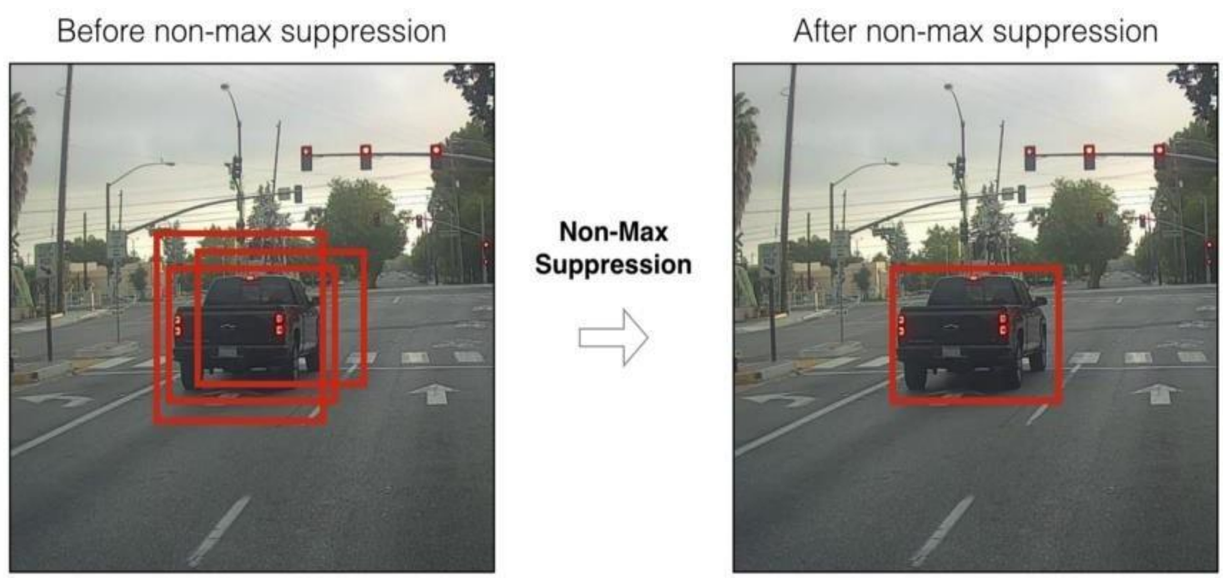


Fig 1: Non-max suppression

3.1.3 IOU (Intersection over Union)

IOU(Intersection over Union) is a term used to describe the extent of overlap of two boxes. The greater the region of overlap, the greater the IOU.

IOU is mainly used in applications related to object detection, where we train a model to output a box that fits perfectly around an object. For example in the image below, we have a green box, and a blue box. The green box represents the correct box, and the blue box represents the prediction from our model. The aim of this model would be to keep improving its prediction, until the blue box and the green box perfectly overlap, i.e. the IOU between the two boxes becomes equal to 1.

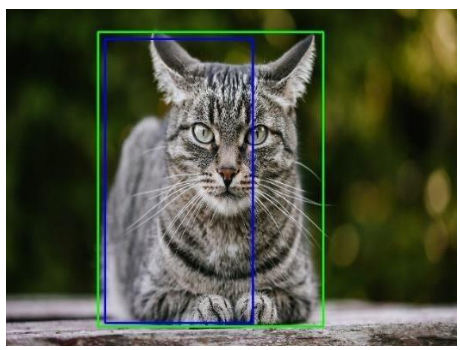
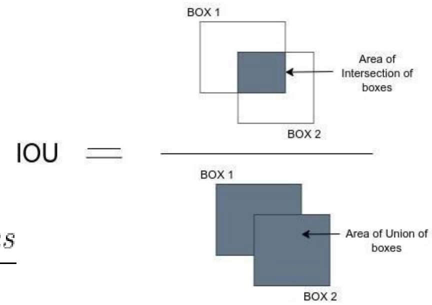


Fig 2: IOU



$$IOU = \frac{Area\ of\ Intersection\ of\ two\ boxes}{Area\ of\ Union\ of\ two\ boxes}$$

3.1.4 YOLO Architecture

Detection at three Scales

The YOLOv3 makes detections at three different scales. Its output is generated by applying a 1 x 1 kernel on a feature map. In YOLO v3, the detection is done by applying 1 x 1 detection kernels on feature maps of three different sizes at three different places in the network.

The shape of the detection kernel is 1 x 1 x (B x (5 + C)). Here B is the number of bounding boxes a cell on the feature map can predict, and C is the number of classes.

Architecture

YOLO v3 makes prediction at three scales, which are precisely given by down-sampling the dimensions of the input image by 32, 16 and 8 respectively.

The first detection is made by the 82^{nd} layer. For the first 81 layers, the image is down sampled by the network, such that the 81^{st} layer has a stride of 32. If we have an image of 416 x 416, the resultant feature map would be of size 13 x 13.   One detection is made here using the 1 x 1 detection kernel, giving us a detection feature map of 13 x 13 x 255.

Then, the feature map from layer 79 is subjected to a few convolutional layers before being up sampled by 2x to dimensions of 26 x 26. This feature map is then depth concatenated with the feature map from layer 61. Then the combined feature maps is again subjected a few 1 x 1 convolutional layers to fuse the features from the earlier layer (61). Then, the second detection is made by the 94th layer, yielding a detection feature map of 26 x 26 x 255.

A similar procedure is followed again, where the feature map from layer 91 is subjected to few convolutional layers before being depth concatenated with a feature map from layer 36. Like before, a few 1 x 1 convolutional layers follow to fuse the information from the previous layer (36). We make the final of the 3 at 106th layer, yielding feature map of size 52 x 52 x 255.

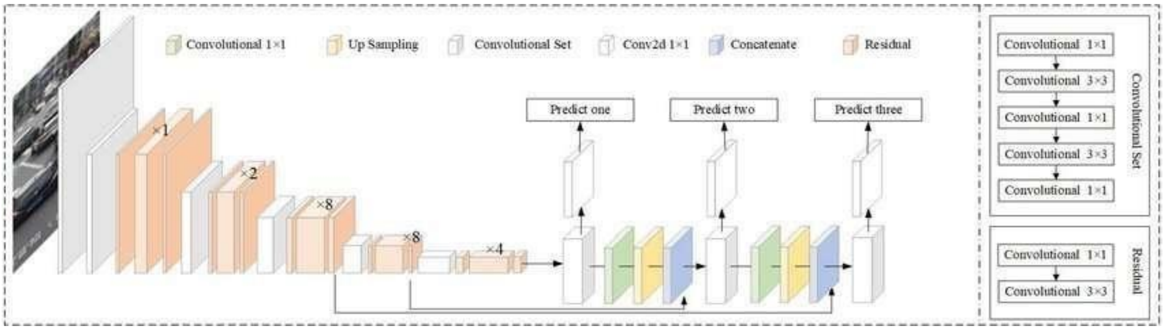


Fig 3: YOLOv3 architecture

Layers:

1. **Convolutional layer**

   it is convolutional layer with batch normalization and activation as leaky ReLU

2. **Residual layer**

   Residual layer is a skip connection , akin to the one used in ResNet. The output of the residual layer is obtained by adding feature maps from the previous layer and the nth(here 2 layers) layer backwards from the residual layer.

3. **UpSampling**

   Upsamples the feature map in the previous layer by a factor of stride using bilinear upsampling.

4. **Concatenate**

   It returns the concatenated feature maps of the layers

3.2 Centroid Tracking Algorithm

Centroid Tracking Algorithm is a multi-step object tracking algorithm which relies on the Euclidean distance between existing object centroids (i.e. the objects which centroid tracker has already seen before) and new object centroids between subsequent frames in the video.

Centroid tracking algorithm consists of five steps which are as follows:

STEP I : Accept Bounding Box Co-ordinates and compute Centroids

STEP II : Compute Euclidean distance between new bounding boxes and existing objects

STEP III : Update Co-ordinates of the existing objects

STEP IV : Register new object

STEP V : De-register old objects

Accept Bounding Box Co-ordinates and compute Centroids

The centroid tracking algorithm assumes that we are passing in a set of bounding-box *(x, y)*-coordinates for each detected object in **every single frame**. These bounding boxes can be produced by any type of object detector like R-CNNs (in this case YOLOv3) provided that they are computed for every frame in the video. Once we have the bounding box co-ordinates, we must compute the "centroid", or more simply, *the center (x, y)-coordinates* of the bounding box.

Compute Euclidean distance between new bounding boxes and existing objects

For every subsequent frame in our video-stream we compute object centroids; however, instead of assigning a new unique ID to each detected object (which would defeat the purpose of object tracking), we first need to determine if we can *associate* the *new* object centroids with the *old* object centroids. To accomplish this process, we compute the Euclidean distance between each pair of existing object centroids and input object centroids.

Update Co-ordinates of the existing objects

The primary assumption of the centroid tracking algorithm is that a given object will potentially move in between subsequent frames, but the *distance* between the centroids for frames F_t and F_{t+1} will be smaller than all other distances between objects. Therefore, by associating centroids with minimum distances between subsequent frames we can build our object tracker.

Register new objects

In the event that there are more input detections than existing objects being tracked, we need to register the new object. “Registering” simply means that we are adding the new object to our list of tracked objects by assigning it a new object ID and then storing the centroid of the bounding box coordinates for that object.

De-Register old objects

The De-registration process is done if any existing object is absent from the video frame for N subsequent frames.

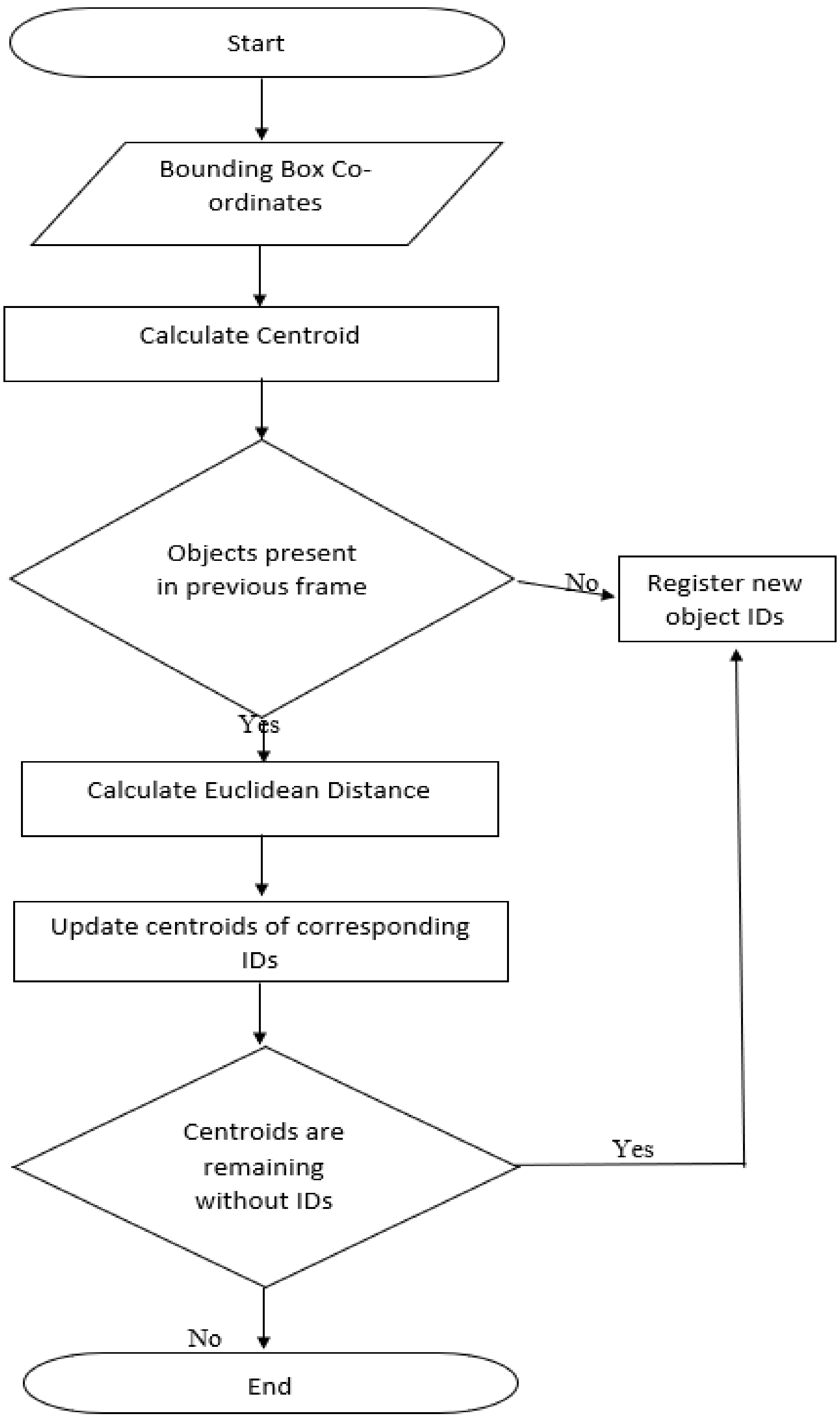


Fig 4. Centroid Tracking Algorithm for registration of new objects

3.3 SYSTEM SPECIFICATION

For this project we need but only a camera and a processing unit to run the software in question which will help automate the process of object detection and violation detection. Our objective is to verify the rule breakers and save their license plate information. The main objective of the project undertaken or the output we desire in real world is to make people follow traffic rules.

We will use the Python language and OpenCV library for the purpose of processing the video and identify objects, identify wrong way driven vehicles, people one the two wheelers that are not wearing their helmets and to identify and read the name plate or license plater information of such rule breakers. We will use Yolo v3 for object detection.

And centroid tracking algorithm for wrong way driven vehicles. The expected result is that after the system is installed the user just has to check the license plates recorded of the rule breakers. The object detection and rule violation should be checked by the system automatically.

Technical Specifications

This system is implemented on the Windows 10 Operating System with Intel i5 CPU. Since the system does not have GPU, the training part was done using online platforms such as Google Colab which gives access to GPU for limited period of time. For taking input videos, a mobile camera is used and we drove vehicles in the wrong way.

4. SYSTEM DESIGN

The architecture of the system is simple as there are not many hardware components needed. We need a processing unit capable enough to run the model and process the video inputted by the input device, i.e camera. Following are the components (hardware) used/ needed in the project :-

- Camera
- A Processing Unit - Computer

The components that make up the overall detection system are only two. Following fig.4, is the activity diagram to help understand how the control flows with the help of all the activities tang place since the start of the system. Firstly, as we start the system the camera starts feeding the input video to the system then the model trained with Yolo algorithm does its job and detects the number of objects there are in the video.

For two-wheelers the helmet is detected is checked by the system and if the vehicle is being driven is driven in the wrong-way then a violation is made so the license plate is identified and recorded with OCR.

4.1 Activity Diagram

An activity diagram portrays the control flow from a start point to a finish point showing the various decision paths that exist while the activity is being executed.

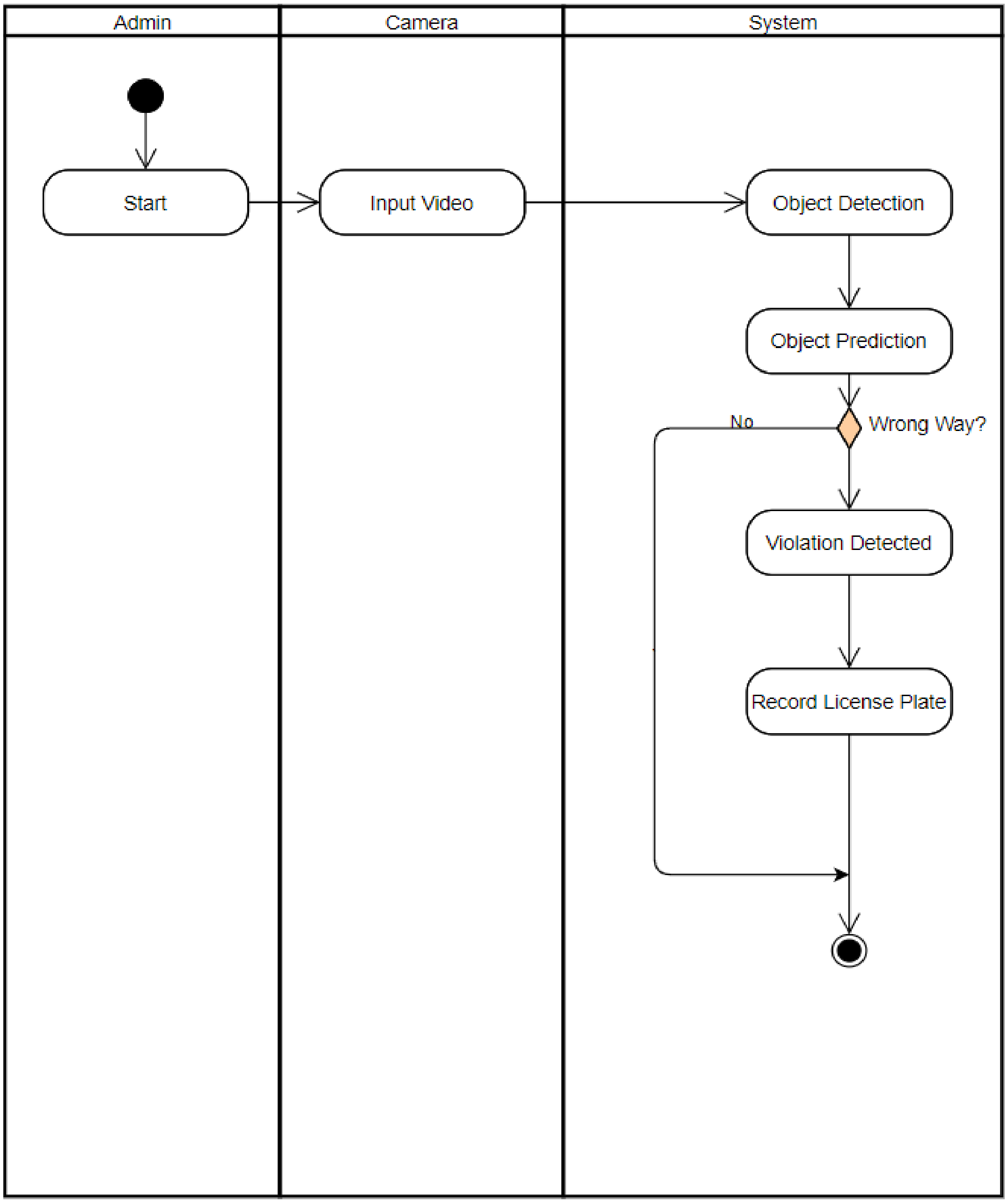


Fig 5. Activity Flow Diagram of the system

4.2 Use Case Diagram

A use case diagram summarizes the details of your system's users (also known as actors) and their interactions with the system.

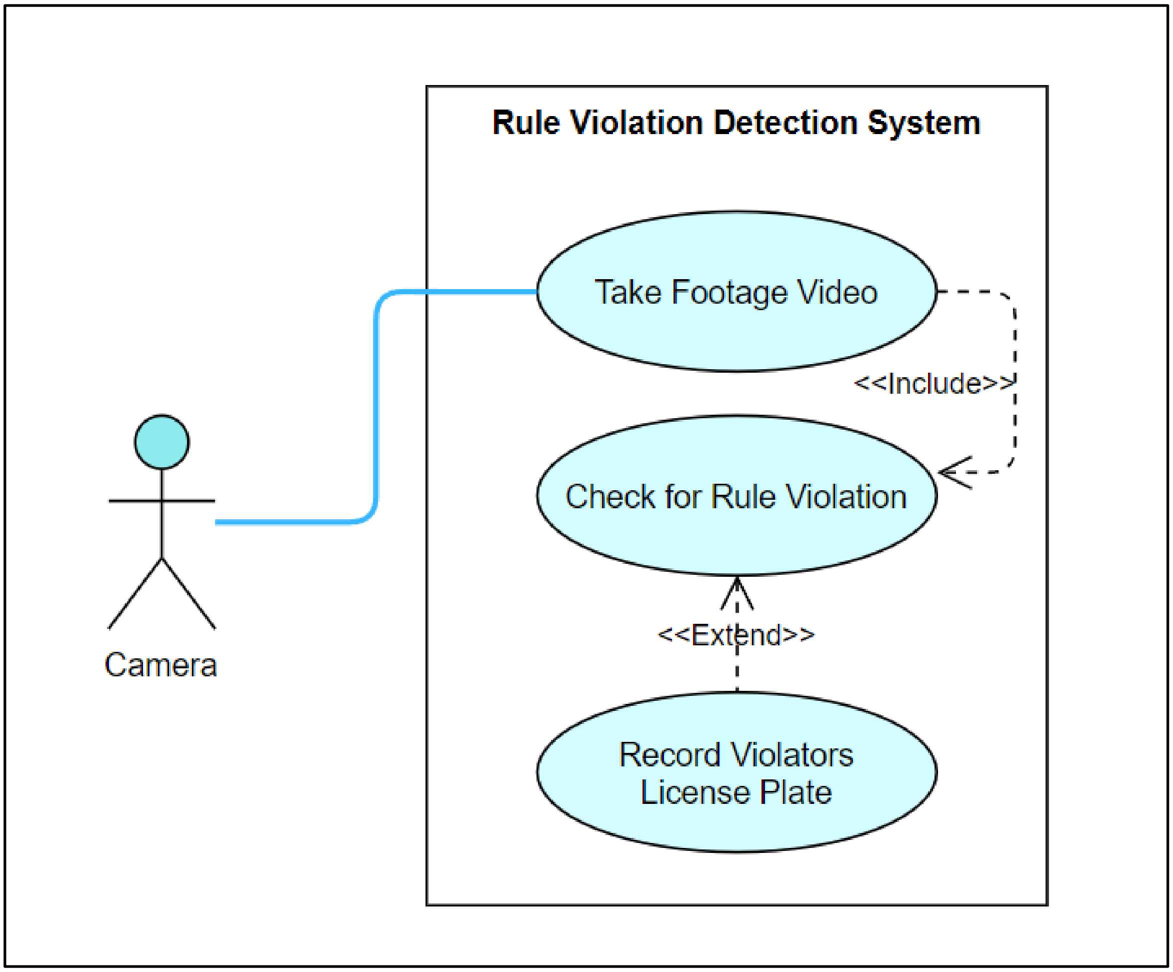


Fig 6. Use Case Diagram of the System

4.3 Sequence Diagram

A sequence diagram shows object interactions arranged in time sequence in the field of software engineering. It depicts the objects involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of scenario.

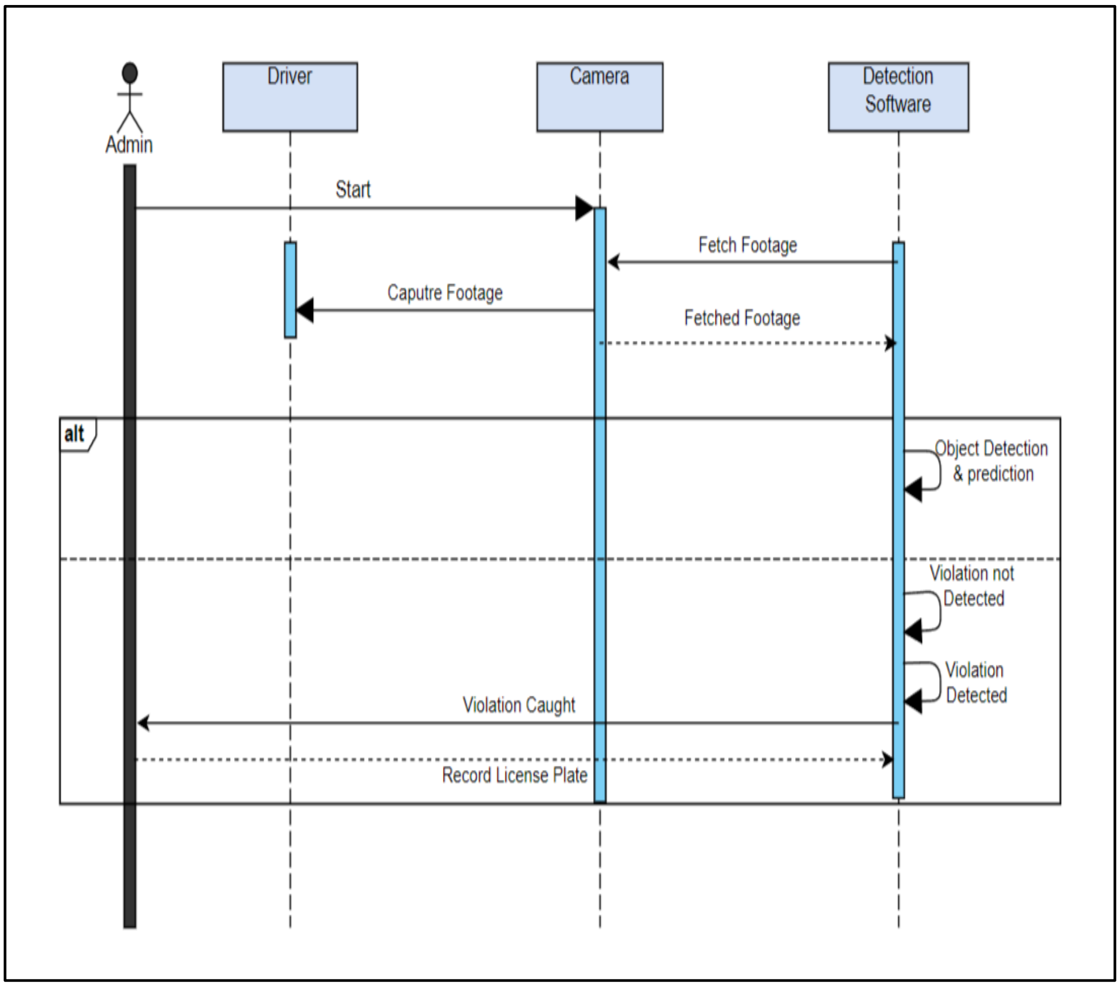


Fig 7. Sequence Diagram of the System

4.4 Class Diagram

Class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing and documenting different aspects of a system but also for constructing executable code of the software application.

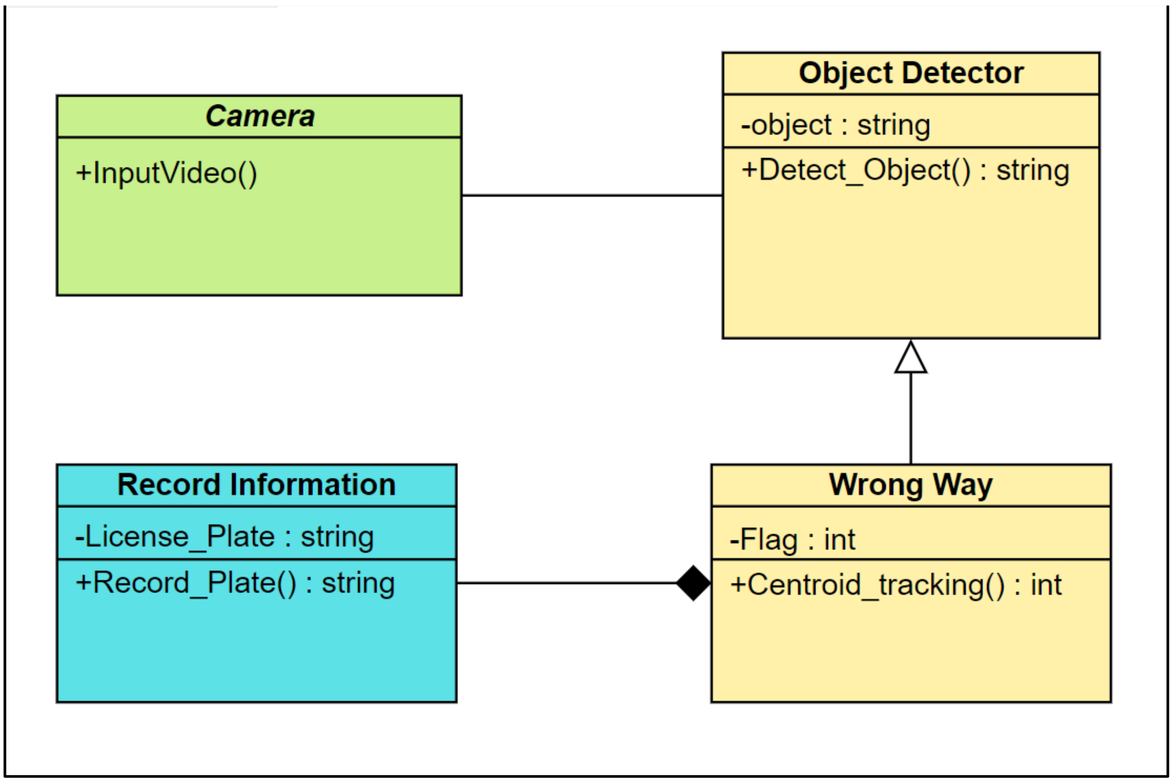


Fig 8. Class Diagram of the Detection System

4.5 Architecture Diagram

Architecture diagram is a visual representation that maps out the physical implementation for components of a software system.

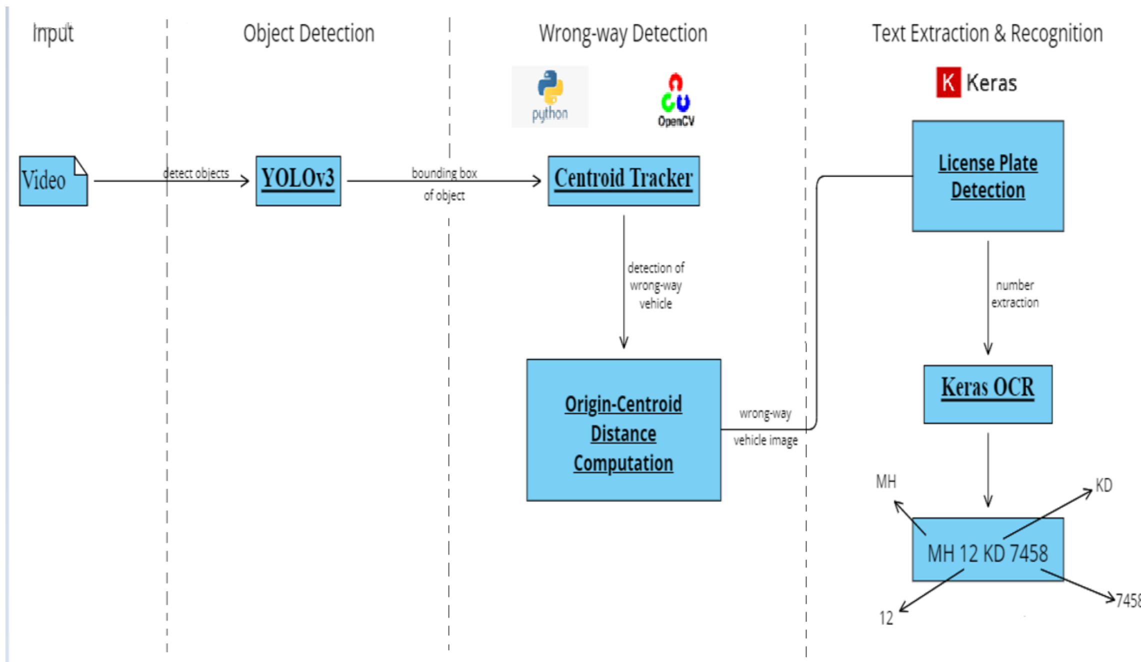


Fig 9. Architecture Diagram

4.6 DFD Level 0

It is also known as a context diagram. It is designed to be an abstraction view, showing the system as a single process with its relationship to external entities. It represents the entire system as a single bubble with input and output data indicated by incoming/outgoing arrows.

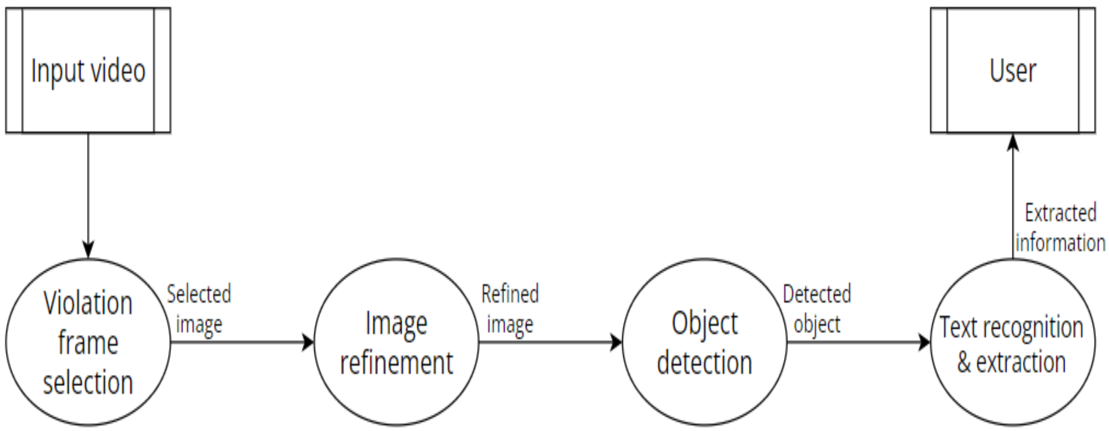


Fig 10. Level 0 Data Flow Diagram

4.7 DFD Level 1

In DFD Level 1, the context diagram is decomposed into multiple bubbles/processes. In this level, we highlight the main function of the system and breakdown the high-level process of 0-level DFD into subprocess.

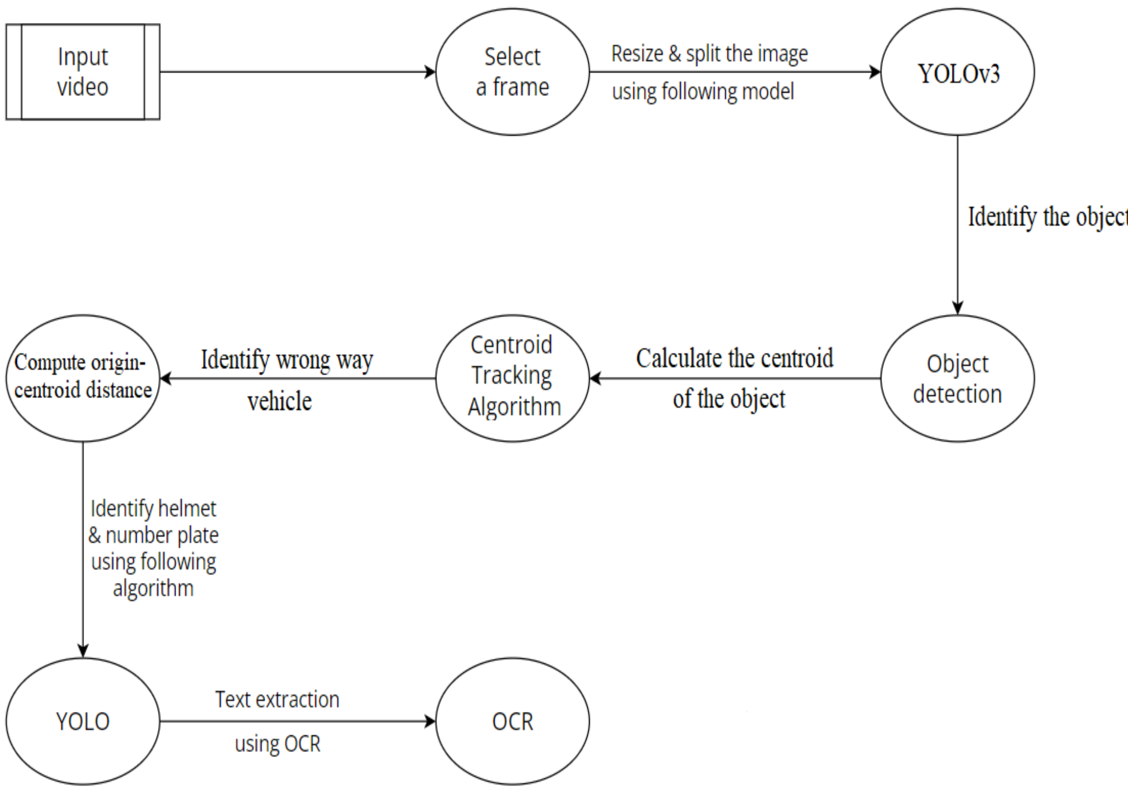


Fig 11. Level 1 Data Flow Diagram

5. SYSTEM IMPLEMENTATION

5.1 Algorithm and Flowchart

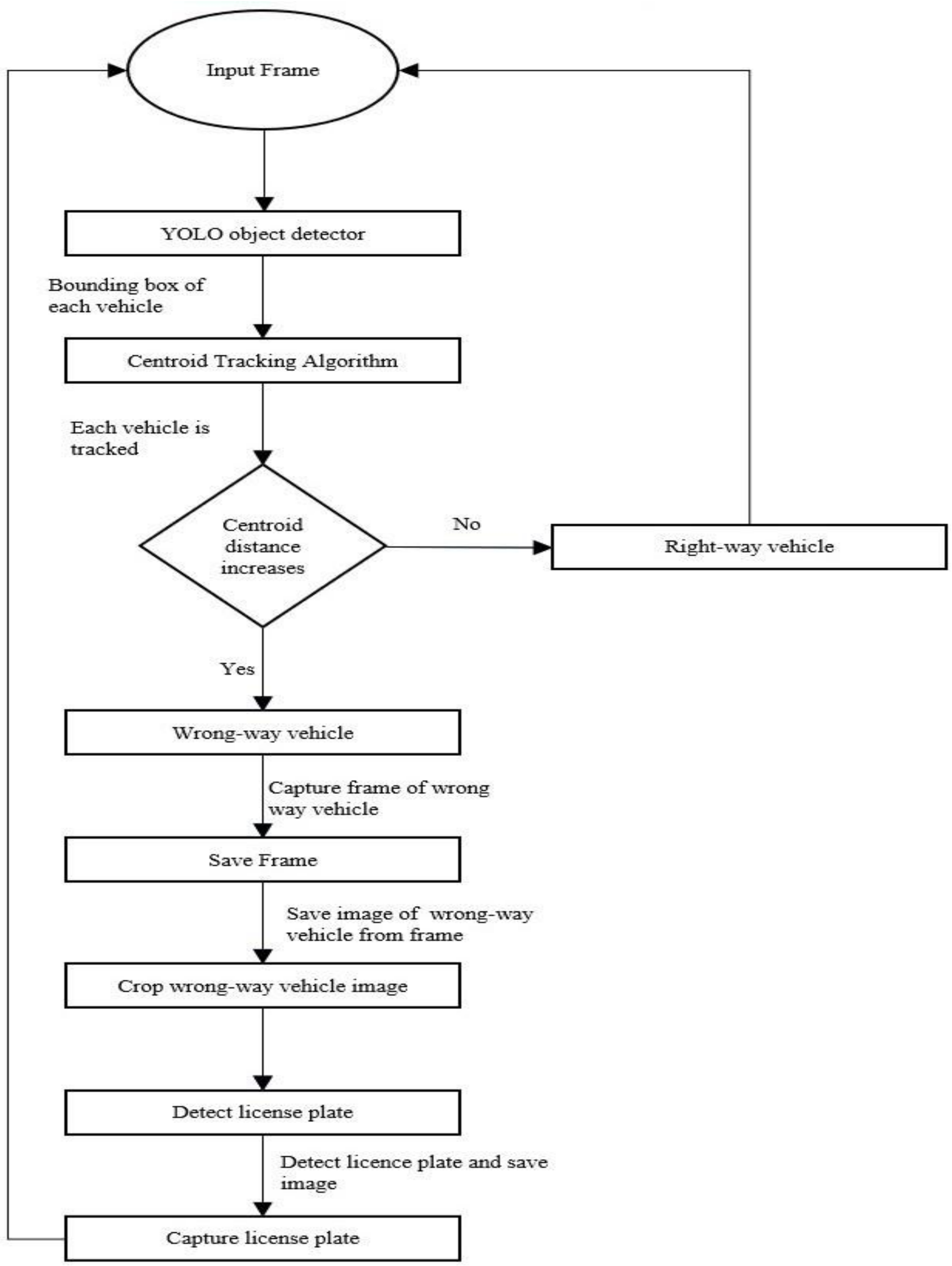


Fig 12 : Flowchart

Algorithm

STEP I :- Take a input frame from video.

STEP II :- Run YOLOv3 object detector on frame for detecting the vehicles and generating bounding box.

STEP III :- Use centroid tracking algorithm for tracking vehicle in subsequent frames.

STEP IV :- If centroid continues to increases in upcoming certain frames vehicle is traveling in wrong-way direction.

STEP V :- Save the frame and vehicle for which wrong way is detected.

STEP VI :- Run license plate detector for captured vehicle and save the license plate

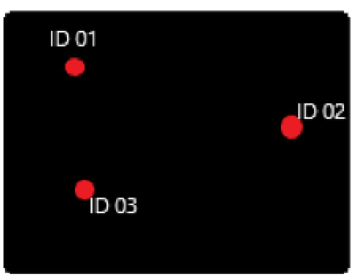
STEP VII :- Run Keras OCR on Licence Plate

5.2 Wrong-Way Vehicle Detection

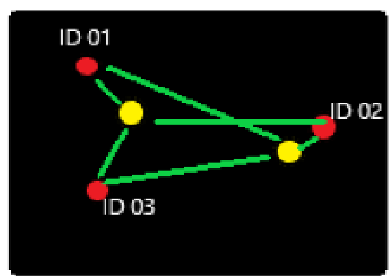
5.2.1 Vehicle Tracking

To track each vehicle, we use the centroid tracking algorithm. This algorithm takes the bounding box as the input. So first, the bounding boxes are generated using YOLO.

Then, those boxes are fed to the centroid tracker. When the center of each vehicle that means the center of the corresponding bounding box enters the video frame, it is given a unique identification number which is shown in Fig. 13a. In the next frame, the center of all the objects move in another place or maybe not have any movement which is shown in Fig. 13b.



(a)

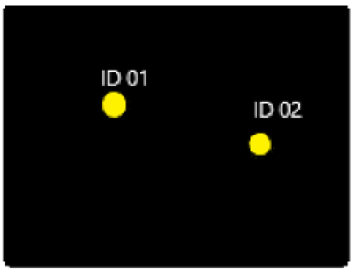


(b)

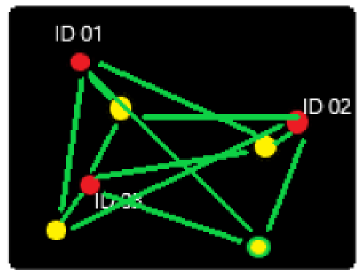
Fig. 13: (a) The first frame (b) second frame

The centroid tracking algorithm is based on an assumption which is that each object will move very little in between the subsequent frame. So, if we can relate any new centroid which has the minimum distance with an old centroid, we can say that this object is previously identified and the new centroid of that object will be updated. This is shown in Fig. 14a.

To do this, all possible Euclidean distance between each pair of the new centroids (yellow color) and the old centroids (red color) are computed.



(a)



(b)

Fig. 14: (a) updated frame (b) when a new frame has more object

If the current frame has fewer objects than the previous frame, which is shown in Fig. 13b, that means one or more objects are disappeared from the video frame. As their centroids are not in the video frame, the ID of those vehicles will be removed from the tracked vehicle list.

But, when the number of objects in the current frame becomes more than the previous frame which is shown in Fig. 14b then there must be a new object. The algorithm will be updated and old objects will be assigned new centroids. The remaining objects will be identified as new objects and given a new identity number.

5.2.2 Wrong-way vehicle detection

The centroid of every tracked vehicle has a height from the top of the frame. When the vehicle is registered first and given an identity number, the distance of the centroid from the origin which is the top left corner of the video frame D1 is computed and stored.

In the next frame, the distance of the centroid D2 is computed and stored in. These distances D1 and D2 are updated in each consecutive frame. If the vehicles move, the D1 and D2 of a vehicle will not be equal. By comparing these two distances, system will predict the direction of the vehicle. In our system, we defined that if the vehicle moves towards the camera, it will be detected as a wrong-way vehicle.

So, if D1 < D2 then, the vehicle is coming towards the camera and is in the wrong way . Our system will detect it as a wrong-way vehicle. The opposite can also be defined just by changing the condition. After the detection of such a vehicle, an image of the frame will be captured automatically. This frame is then cropped using bounding box co-ordinates of the vehicle to obtain the cropped image of the vehicle and the cropped image is used for further inspection.

5.3 Helmet Detection

Helmets are one of the essential key safety factors for motorcyclists. Unfortunately, their use is not increased particularly where the rules for not wearing helmet is strict. The goal of this procedure is to provide an automated system approach to detect motorcyclists with and helmet.

The machine systems used for detection and classification from images and video require features. Feature extraction manually is an invincible work. So, convolutional neural networks (CNN) have obtained its importance in achieving good accuracy for image classification in few years back. CNN learns the whole image by extracting features using feature map and has proven to obtain better detection and classification. Transfer learning is used on CNN model, Yolov3-tiny Darknet trained in advance on the COCO dataset. This information has encouraged in acquiring high precision in order.
Helmet can be detected in following steps:

1. Input images/frames
2. Pre-process
3. Train model
4. Predict (class)

Firstly, the raw images are preprocessed by resizing according to the set parameters. The preprocessed are fed to the training model. The trained model is then used to predict class objects.

Yolov3 splits the picture into a matrix of N by N cells, every one of these cells is answerable for the forseeing particular bouncing boxes. A bounding box depicts the square shape that encases an article object. It additionally gives a certainty score which represents the determined bounding box that contains specific object. The model is applied to an image at different scales and positions. The regions obtained with high score from the image are examined as detections. At a particular instance of a time, one neural network is applied to the entire image. It then predicts probabilities and bounding boxes for particular region. The predicted probabilities assign weights to the bounding boxes.

The training process involved manually labelling specified class objects in the images using LabelImg tool that returns coordinates of labelled objects in the form of text. The tool will give the position of the coordinate with four points, and also class label.

Steps to detect Helmet are as follows :

a) Take an input image.

b) Resize the image.

c) Divide the image into N by N cells.

d) Get the bounding box from each of the cells and assign weights.

e) Get the confidence score for each cell and select with highest score for detection.

f) Print the bounding box on detections of an output image

g) Display the output image.

5.4 OCR

Optical Character Recognition (OCR) is a majorly deployed innovative technology which converts over pictures of printed, handwritten characters into machine-encoded content data.

5.4.1 Character segmentation

It's the separation of the different characters of the number plate. From the picture in the study, the main procedure will be to extract all the number plate characters from beginning to end, leaving all the extra wide spaces from top to bottom and from left to right. Characters are similarly fit in the plate section. For a simple correlation of the info character with the character in the information base.

5.4.2 Optical character recognition

Optical Character Recognition (OCR) is the transformation of pictures of typed, written by hand or printed content into machine-encoded content. It segregates the various characters found in the image. One of the methods used in OCR is layout coordinating. The edited picture is contrasted, and the layout information put away in the database. As a result, OCR discerns and perceives the characters with no roundabout info.

6. RESULTS AND EVALUATION

6.1 Experimental Setup and Testing Strategy

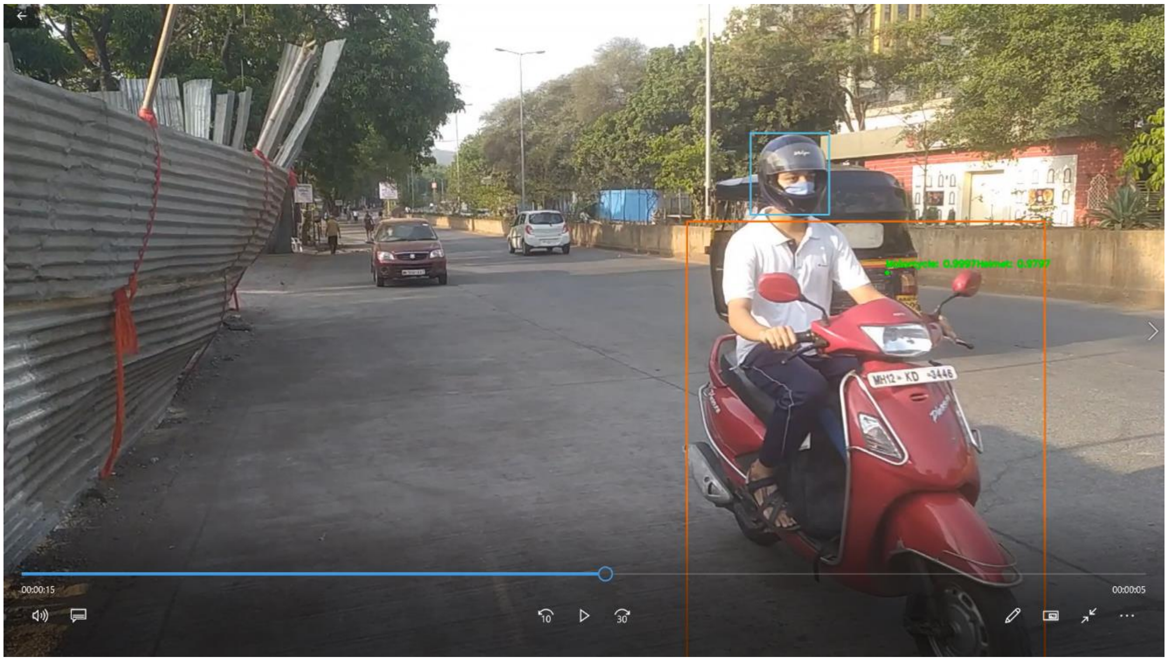
After the primary coding was completed the system was tested with a custom self made video. A scooter was driven towards the camera and the system successfully detected and cropped the license plate as intended. The Passing vehicles moving away from the camera i.e were also detected along with helmets, truck, cars, bikes, etc.

But the accuracy reduced with clustering of a lot of passing vehicles. So, more training was required on images with clustered up vehicles. As there are many situations possible a certain number of permutations were made and the model was run on it.

For example, a car driven in wrong direction, a car and a two wheeler driven in wrong direction were the two important scenarios that were tested with the system where the license plate was successfully detected and the image was cropped of the vehicles.

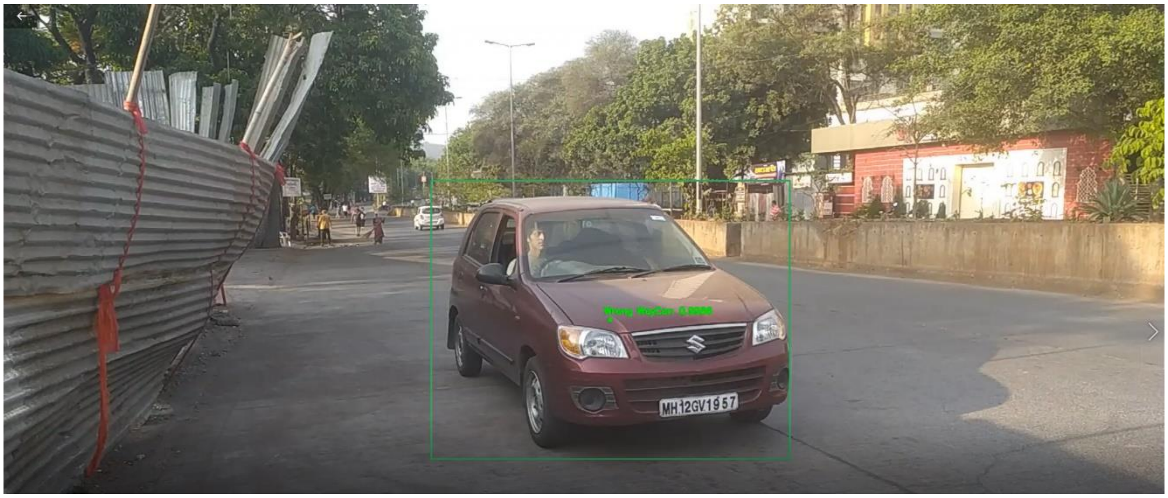
6.2 Output

The system generates one output video and captures images of the violators. Here are the screenshots from the video



The helmet is detected and is marked with blue colour

Car is detected



Car is marked as Wrong way in the Output Video.

Vehicle number recognized using OCR.

6.3 Test Cases

Case 1 : Only one vehicle in wrong way

Motorcycle driven in wrong way

Cropped image of the Motorcycle

Case 2 : Multiple Vehicles violating Wrong Way Rules

Motorcycle driven in wrong way

Car Driven in Wrong way

Cropped Images of The Vehicles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Summary and Evalutaion

The system was tested on the above mentioned scenarios with decent results. The main purpose of the system was to detect wrong way driven vehicles and helmet detection which the system detected successfully. A problem that occurred during the initial testing was detection had low accuracy. This problem was over come by using custom images taken on a smartphone and the model was trained on them.

The system works as intended but the processing time is higher than what would be ideal. But if better hardware is made available it is entirely possible to have a faster system and then deploy the working model presently thereafter.

7. CONCLUSION

Thus, we introduced a framework that can distinguish traffic rule infringement like wrong way and imprint it from on-street video film. In the principal stage, each motor vehicle in the video outline is recognized utilizing the YOLO object detector algorithm as it is extremely precise and quicker than any other object detection calculation. Then, the bounding boxes produced by the YOLO algorithm are taken care of to the centroid tracking algorithm. The following calculation tracks every motor vehicle in the video outline. Then, by figuring the centroid distance from the beginning for every vehicle in successive edges, the heading of vehicles not entirely settled and we can determine if the vehicle is heading down the correct path or not. We also detect helmet using YOLO algorithm. Lastly, we detect license plate and perform OCR for text recognition.

8 FUTURE WORK

This system detects wrong way on one side of the road. In future, this can be implemented on both sides of the road by creating two regions and running this algorithm separately on those regions. The processing time of the system can also be improved on suitable hardware.

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Recognition”, IJSTE - International Journal of Science Technology & Engineering | Volume
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Advances on Traffic Rules Violation Detection using Artificial Intelligence

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Summary. Road is one of the most important modes of transport in India and it has the largest network of roads in the world. But with large population, lack of man power and technology, road accidents have become a part and parcel of life. Most of the times, the accidents are caused due to the violation of traffic rules by the people. So, to ensure safety of people on the streets of India, pinpointing the traffic rule violators is a highly prudent job but also difficult because of numerous obstacles. In this paper, we propose a framework of a system for detection of violation of some of the traffic rules like wrong way using centroid tracking algorithm, two-wheeler riders wearing helmets or not. After the violators are detected, the license plate of those vehicles is detected and the text information is extracted using OCR, and the violators are notified. Thus, a complete autonomous system will help to strengthen the traffic management system.

Keywords: YOLO, centroid, wrong-way, OCR

1 Introduction

In a highly populated developing nation like India, road accidents are very common. Due to large population, we need lots of vehicles for transportation. This results in lots of traffic on the roads. Heavy traffic congestion leads to violation of traffic rules, which in turn leads to accidents.

According to the Ministry of Road Transport and Highway, our country ranks high in the number of demises caused because of road accidents across many countries in the world. A total of around 4,50,000 road accidents were reported across India in 2019. These mishaps claimed around 1,51,000 lives and 4,51,361 were injured. Among these numbers, youths are the main sufferers. So, to compel people follow traffic rules, it is necessary to give a quick response to the violations done by them.

So, in this paper, we propose a system on traffic rules violation detection, where we detect violation of rules like vehicles going in wrong way and two-wheeler riders not wearing a helmet and we detect the license plate of the vehicles which break the rules and the owners of the vehicles get notified.

2 Literature Survey

The current framework in our country utilized for discovery of infringement and rebuffing the violators works physically. The CCTV cameras on the roads capture the traffic the entire day. These ongoing footages are then observed by the traffic police group in the control room and when they identify any infringement, the tag is noted and a screen capture is caught as a proof. Then the police make an impression on the violator consequently charging them a fine. Thus, we propose a computerization of this interaction.

For vehicle identification, Prem Kumar Bhaskar [1] had proposed to foster a calculation utilizing Gaussian combination model and mass recognition techniques. Notwithstanding, the disadvantage in this strategy was that the mass location required progressive picture outlines for discovery. Kunal Dahiya [2] proposed a methodology that initially identifies all articles from observation recordings utilizing foundation deduction and item division. Then includes were removed utilizing techniques like Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG), Scale Invariant Feature Transform (SIFT) and a twofold SVM classifier to order the items. Be that as it may, the foundation deduction was impacted by the shadow of the actual vehicle.

For wrong way detection, computer vision innovation is being utilized in numerous frameworks. M. J. Caruso [3] proposed a sensor-based strategy which utilized attractive sensor to identify the course of the vehicle. However, the disadvantage in this framework was that the attractive field changed because of different reasons as well, hence not giving good outcomes. The structure proposed in [4] utilized movement design-based technique utilizing optical stream estimation. It utilized optical stream estimation to discovery the heading of the vehicle and contrast it and displayed path bearing. In any case, this technique dealt with issues in view of impediment. Further developed optical stream assessment was utilized by H. H. Nguyen [5]. He utilized foundation deduction and Lucas-Kanade strategy to recognize incorrect way vehicles. However, this framework ended up being a disappointment on the grounds that in various light circumstances, the foundation deduction strategy was exceptionally impacted by the shadow of the actual vehicle.

For distinguishing riders regardless of helmet, a few frameworks utilized the techniques like LBP, HOG and SIFT. Yet, these strategies got some margin for carrying out and made the cycle slow. J. Chiverton [6] proposed a methodology by thinking about the intelligent properties of a material. The estimated district of the top of the rider was separated, which was utilized as a component that was gotten from histogram tasks applied to the area. It was seen that the highest point of the heads was more brilliant than the lower part of the protective helmet. The downside with this approach was that the technique depended on the idea of reflection which might shift for various surfaces and furthermore more than adequate measure of light ought to be available to have a huge contrast among upper and lower surfaces for location. Gomathi [7] suggested a methodology for recognition of helmet utilizing Arduino microcontroller, IR sensors, RF transmitter and power supply. In any case, this elaborate part of equipment which required a great deal of support which made it exorbitant. The chance of equipment being harmed was likewise high.

In the wake of identifying the vehicles utilizing object identification and arranging them as per the infringement, the tag of the relating vehicle must be perceived. Amey Narkhede [8] proposed a methodology utilizing Edge discovery to find the limits of the items, Hough change for highlight extraction and line identification and in conclusion K-closest neighbour to perceive the divided characters. Numerous different frameworks likewise utilized Canny edge recognition however the downside in utilizing this strategy was that it recognized every one of the edges in the picture and it turned out to be computationally costly to choose just those edges which really had a place with the tag.

3 Previous Results

In this section, we are presenting the comparison of previous results of object detection, helmet detection and license plate detection using different methods.

Comparison of results obtained for object detection using different methods

Method	Car	Person	Sign	Line
RCNN	82.56	58.93	63.59	77.15
FCN	81.22	55.46	61.96	74.79
SSD	77.36	48.96	51.82	69.00

All values are in percentage.

Comparison of results obtained for helmet detection using different methods

Method	S	NPV	P	R	FM	K	A
WT	93.27	71.32	94.12	74.17	82.96	64.36	81.96
HOG	93.27	75.19	94.44	78.81	85.92	69.48	84.71
LBP	75.00	47.27	71.11	42.38	84.67	15.93	55.69

S = Specificity

NPV = Negative Productive Value

P = Precision

R = Recall

FM = F-Measure

K = Kappa Coefficient

A = Accuracy

WT = Wavelet Transform

HOG = Histogram of Oriented Gradients

LBP = Local Binary Patterns

All values are in percentage.

Comparison of results obtained for license plate recognition using different methods

Accuracy Rate of LPR	Traditional CCA	Active Contour
Detection rate of license plate	96.4 %	96.4 %
Accuracy of character segmentation	78.6 %	76.1 %
Avg time of segmentation (in seconds)	0.196	2.21
Character recognition rate	98.7 %	98.7 %
Overall recognition rate	74.5 %	71.9 %

CCA = Connected Component Analysis

4 Proposed System

In this part, we will clarify the proposed end for end framework. In the proposed framework, we will initially give a picture outline from the video as contribution to the framework and afterward perform object location. For object identification, we will utilize You Only Look Once (YOLO) calculation, where it will distinguish vehicles, cap and tag. Subsequent to recognizing vehicles, individual vehicles will be edited out utilizing organizes acquired from bouncing boxes. Presently a singular vehicle will be checked against various infringement. Infringement remembered for this proposed framework are Wrong-way infringement.

A. Vehicle Detection

There are many methods at hand to identify the vehicles in a frame with bounding boxes. But we will be using YOLOv3, as it provides more speed and accuracy.

The important point about YOLO is that it takes a look at the picture once and determines each item with class likelihood and bounding box and to that end it is extremely quick contrasting and other article location calculation. In the first place, it partitions the pictures into the MxM lattice cell. Every cell can have B bounding boxes. In the event that there are C number of classes, the total bounding box will be MxMxB and each case will have (5+C) credits. Four ascribes for the crate direction and one is for certainty score that this case contains one of the C classes. There is an edge certainty score. These tasks are finished in a solitary pass through the organization. There is an issue when various recognitions of a similar article occur. To defeat this, a cycle called non-max concealment is utilized. In this interaction, initial, a container with the most noteworthy certainty score is chosen. Then, at that point, the crates which have cross-over in excess of a limit esteem with the recently chosen box will be eliminated. This cycle guarantees just a single bounding box for every article. In YOLOv3, the creators provide a new more profound convolutional brain organization (CNN) to remove the elements. It has 53 convolutional layers. Group standard and Leaky ReLU initiation work were applied to each convolutional layer. The elements of the info picture are extracted by these convolutional layers.

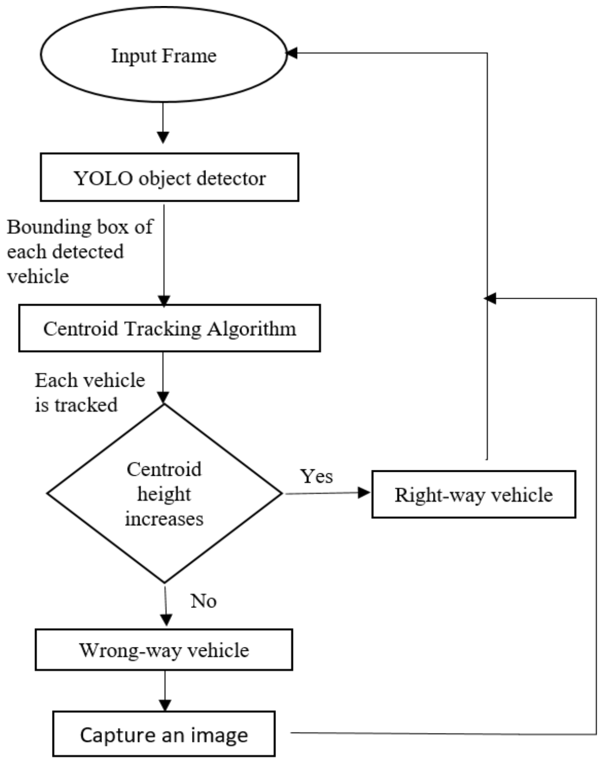
B. Wrong-Way Detection

For wrong way detection, we will utilize Centroid Tracking algorithm. Whenever the vehicle enters in the edge of the video, really at that time it will be followed. Presently, centroid following calculation takes the bounding boxes as info. In this way, the bounding boxes made by YOLO will be taken care of to the centroid tracker. At the point when the focal point of every vehicle that implies the focal point of the comparing bounding box enters the video outline, it is given a remarkable distinguishing proof identity as displayed in the figure 1a. In the following casing, the focuses of the relative multitude of items move in somewhere else or perhaps not have any development which is displayed in figure 1b. The centroid following calculation depends on a presumption which is that each item will move very in the middle between the ensuing edge. Thus, on the off chance that we can relate any new centroid point which has the base distance with an old centroid, we can say that this item is recently distinguished and the new co-ordinate of that article will be refreshed. To do this, all conceivable Euclidean distance between each set of the new co-ordinates (yellow tone) and the old co-ordinates (red tone) are figured. The Euclidean distance d between two pixels (xi,yi) and (xj,yj) is as follows:

$$d=\sqrt{(xi-yi)^2+(xj-yj)^2}$$

Assuming the ongoing casing has less items than the past edge, as displayed in figure 1b, that implies at least one object has vanished from the video. As their centroids are not in the video, the identity number of those automobiles will be taken out from the followed motor vehicle list. Yet, when the quantity of items in the ongoing edge turns out to be more than the past casing as displayed in figure 2b then there should be another article. The calculation will be refreshed and old articles will be appointed new centroid points. The excess objects will be recognized as new items and given another identity number. Along these lines, our proposed framework will follow every vehicle freely.

Then, at that point, the last advance is to recognize the vehicle going in wrong direction. The centroid of each and every followed vehicle has a separation from the beginning, which we have considered as the upper left corner of the video outline. At the point when the vehicle is enrolled first and given an identity number, the distance of the centroid D1 will be processed and put away comparing to the character number. In the following edge, the distance of the centroid D2 from upper left corner (beginning) will be registered and put away alongside its character number. These distances D1 and D2 will be refreshed in each successive casing. Assuming the vehicles move, the D1 and D2 of a vehicle won't be equivalent. By contrasting these two distances, our framework will foresee the heading of the vehicle. In this way, assume we characterize that in the event that the vehicle moves towards the CCTV camera, it will be distinguished as a vehicle going in wrong direction. Thus, in the event that D1<D2, the vehicle is coming towards the CCTV camera and is in the wrong direction. If not, our framework will distinguish it as a vehicle going in right direction. The inverse can likewise be characterized just by interchanging the condition.



A flowchart depicting the wrong-way detection system.

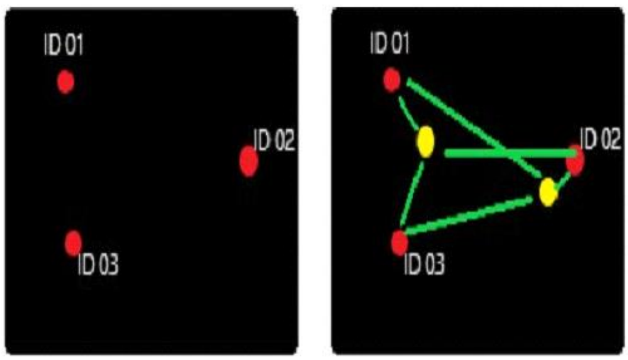


Fig. 1 a)first frame b) second frame

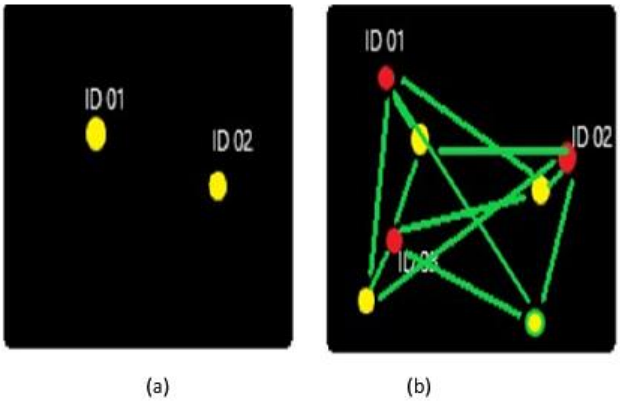


Fig. 2 Updated frame and new frame

C. License Plate Recognition

In license plate recognition, we will be detecting the license plate using YOLO algorithm and for text recognition, we will be using Tesseract OCR.

Optical Character Recognition (OCR) is a significantly sent imaginative innovation which changes over pictures of printed, transcribed characters into machine-encoded content information. Its adequacy is very great at seeing printed characters and physically composed characters. For text acknowledgment, first we will perform character division. It is the partition of various characters on the tag. The fundamental technique will be to extract all the number plate characters from start to finish, passing on every one of the extra wide spaces through and through and from left to right.

Optical Character Recognition (OCR) is the change of pictures of composed, composed the hard way or printed content into machine-encoded content. It isolates the different characters found in the picture. One of the strategies utilized in OCR is format planning. The altered picture is differentiated, and the design data set aside in the information base. Accordingly, OCR observes and sees the characters with no indirect information. OCR for number plate distinguishing proof is less many-sided when the tags have homogenous literary styles when contrasted and different plans.

5 Dataset

We have used a custom dataset for object detection which contains 5 classes and around 580 images. For license plate detection, we have used another custom dataset consisting of 1 class and around 150 images.

6 Conclusion

This paper introduced a framework that can distinguish traffic rule infringement like wrong way and imprint it from on-street video film. In the principal stage, each motor vehicle in the video outline is recognized utilizing the YOLO object detector algorithm as it is extremely precise and quicker than any other object detection calculation. Then, the bounding boxes produced by the YOLO algorithm are taken care of to the centroid tracking algorithm. The following calculation tracks every motor vehicle in the video outline. Then, by figuring the centroid distance from the beginning for every vehicle in successive edges, the heading of vehicles not entirely settled and we can determine if the vehicle is heading down the correct path or not. We also detect helmet using YOLO algorithm. Lastly, we detect license plate and perform OCR for text recognition.

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Program Secretary
Email – support@ict4sd.org,

Once again, I thank you on behalf of the organizing committee for your interest in ICT4SD 2022. Please treat this letter as an Official document for all conference-related activities & quote the Paper No. & Name for future correspondence.

Last Date for Registration and Payments - May 30, 2022 11:59:59 PM IST

Please feel free to send your queries to us if you have any or call the Conference Secretary: +91-72010-90504.

With regards and best wishes.
(Program Secretary, ICT4SD 2022)

SUBMISSION: 352
TITLE: Traffic Rules Violation Detection using Artificial intelligence

----------------------- REVIEW 1 ---------------------
SUBMISSION: 352
TITLE: Traffic Rules Violation Detection using Artificial intelligence
AUTHORS: Nikhil Gadkari, Nikhil Singh, Mihir Athavale, Shaswat Tejankar and Prof. N.R. Sonavane

----------- Overall evaluation -----------
SCORE: 2 (accept)
----- TEXT:
Great paper work.

- Introduction is excellent and clearly objectifies the goal of the study.

- Keywords amount need to be more and should be matched with the research substance.

- Methodology is well explained with the help of proper steps and necessary infographics for better understanding.

- Comparison should be mentioned and discussed in the paper as existing and proposed system both are presented in the manuscript.

- Recommended for Inclusion.

----------------------- REVIEW 2 ---------------------
SUBMISSION: 352
TITLE: Traffic Rules Violation Detection using Artificial intelligence
AUTHORS: Nikhil Gadkari, Nikhil Singh, Mihir Athavale, Shaswat Tejankar and Prof. N.R. Sonavane

----------- Overall evaluation -----------
SCORE: 2 (accept)
----- TEXT:
The work is encouraging however certain points are needed to be addressed.

- Abstract is phenomenal and has interesting findings mentioned.

- Keywords are excellent and accurate to the paper study.

- Learning model is presentable and has conference scope.

- Authors are requested to follow the guidelines issued by springer or the paper may be rejected by the publication board at a later stage.

Gmail **Mihir Athavale <atmihir96@gmail.com>**

ACT2022– Individual Review Result

ACT Chair <act.chair@gmail.com> Mon, May 23, 2022 at 8:41 PM
To: nikhilgadkari777@gmail.com, nns972000@gmail.com, atmihir96@gmail.com

Dear Prof/Dr.Nikhil Singh

Welcome to **ACT 2022**

Congratulations - Your paper for the **Thirteenth International Conference on Advances in Computing, Control, and Telecommunication Technologies - ACT 2022** has been accepted. The **ACT 2022** conference is jointly organised by the IDES and the Association of Computer Electrical Electronics and Communication Engineers (ACEECom) and will be held during **June 27-28, 2021; Hyderabad, India**.

http://act.theides.org/2022/

Paper ID	**ACT2022-19F**
Paper Title	Advances on Traffic Rules Violation Detection using Artificial Intelligence
Category	**Full Paper**

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Best Regards,
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NOTE: Please visit the conference website carefully for any doubt. In all your communications please quote your Paper ID and Category.

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Sudheer
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