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POTHOLES AND TRAFFIC SIGNAL VIOLATION DETECTOR SYSTEM

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Abstract— *This project will be a Machine Learning (ML) based application, which will be using algorithms to detect the potholes on the roads and also the vehicles violating the traffic light. Nowadays, potholes on Indian roads, is major issue for vehicle drivers. Also, the increasing number of cars in cities has caused high amount of traffic, and has given rise to traffic violations. This causes heavy destruction of government as well as private property and accidents that may endanger the lives of the people. To solve the alarming problem and prevent such unfathomable consequences, traffic violation detection systems are needed and at the same time pothole detection on roads is necessary. For which the system makes proper traffic regulations at all times, and make them to follow rules those who does not comply. A traffic violation and pothole detection system must be realized in real-time as the authorities track the roads all the time. Hence, traffic rules be followed properly and protected by everyone efficiently; as the traffic detection system detects violations of traffic faster than humans also detects potholes precisely.*

INTRODUCTION

This project is a ML based system for detecting traffic violation and potholes on roads. System will be implemented using Machine Learning Algorithms in Python. Yolo algorithm will be used for the detection of the vehicles, potholes and speed brakers. DeepSORT algorithm will be used for tracking of this objects. OpenCV libraries will also be used to provide common infrastructure for computer vision. This system will be able to detect traffic signal violation and potholes on roads in real-time. It will track the vehicles present in an ongoing video and also the potholes on the road at the same time. A user friendly graphical interface will be associated with the system to make it simple for the user to operate the system, monitor traffic and take action against the violations of traffic rules. As system will behaving an option to save the image or a video of the preview with tracked object. Firstly, this system will make it easy for the traffic police department to monitor the traffic and take action against the violated vehicle owner in a fast and efficient way. Detecting and tracking the vehicle and their activities accurately is the major priority of the system. Secondly it will help government to track road conditions by detecting potholes.

IMPLEMENTATION

The user will add the video footage to this application. The yolo algorithm will be previously trained over the images. This will increase the accuracy of the algorithm for the custom object detection. The custom objects will include potholes and vehicles. Then the object detection and tracking of object will take place. The detected objects will be categorized into vehicles and potholes. Further the vehicles crossing the traffic line will be detected into violating vehicles category.

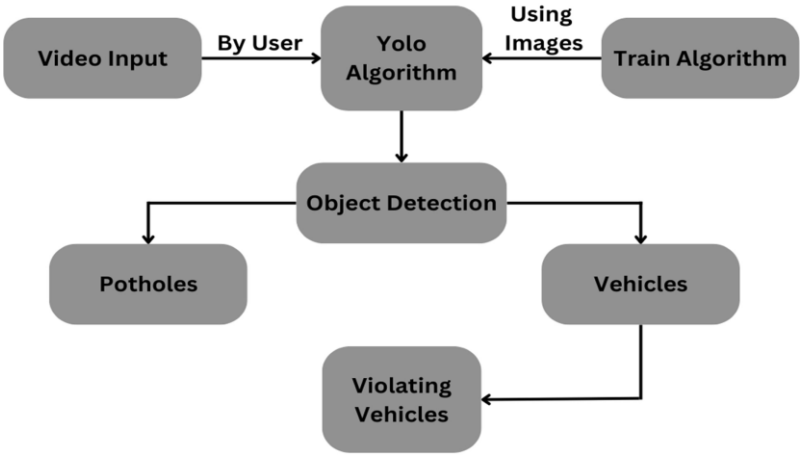

Fig 1: Block Diagram

A. TRAFFIC SIGNAL VIOLATION DETECTION

I. Fundamentals:

A. Image processing Image processing refers to the analysis and manipulation of a digital image to enhance its quality and interpret information present in it.

B. YOLOv3 YOLOv3 algorithm is mainly constructed of a particular connected Convolutional Neural Network. Layers of CNN is a class of deep neural networks (DNN) to analyze digital images or videos. It is a class of multi-layer perceptron, refers to a fully connected network (FCN) in which all neurons of one layer are connected to other neurons in the next layer [1] [2]. CNN is a specialized category of neural networks used effectively to process data in a grid-like manner. Parameter sharing is a distinguishing feature of CNNs, which is of great significance in object detection. CNN's are different from fully connected forward neural networks, each of its trained weight is used, such that in overall CNN architecture every component makes use of the kernel in the input position, meaning that in each location and position, a category of all the parameters is learned instead of a different category of parameters. This property is very valuable in encapsulating the whole entire environment.

C. Tkinter: Tkinter is the Python interface to the Tk GUI toolkit shipped with Python. We would look this option in this chapter. Tkinter is the standard GUI library for Python. Python when combined with Tkinter provides a fast and easy way to create GUI applications. Tkinter provides a powerful object-oriented interface to the Tk GUI toolkit

II. Design and Implementation

The system is based on the ML algorithm to detect the vehicles.

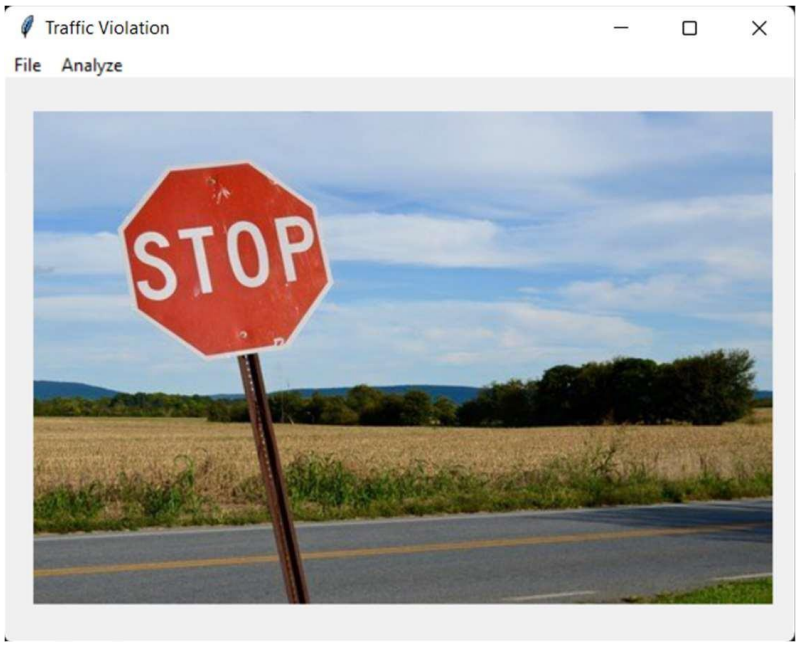

Fig 1 a: Initial User Interface View

Primarily, for the start of the project usage, the administrator needs to open a video footage using 'Open' item that can be found under 'File' (Figure-1 a & Figure-1 b). The administrator can open any video footage from the storage file.

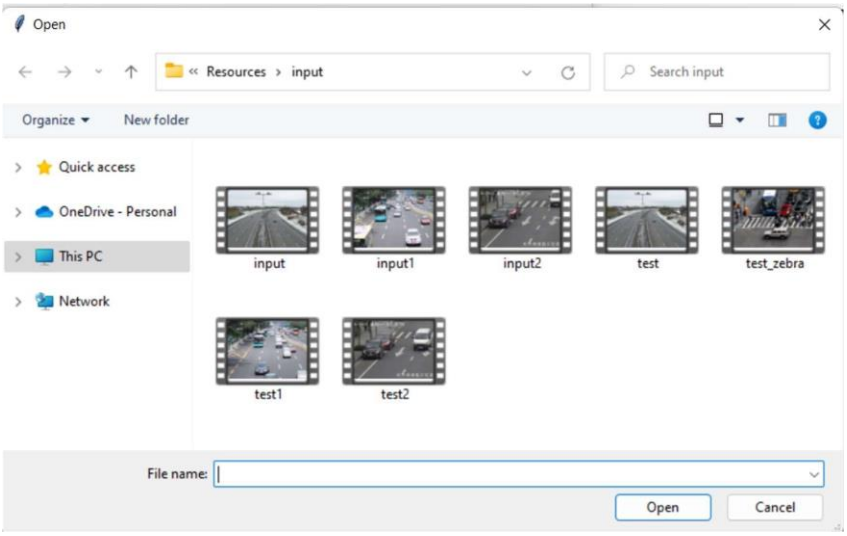

Fig 1 b: Opening a video footage from storage

After opening a video footage from storage, the system will get a preview of the footage. The preview contains a frame from the given video footage. The preview is used to identify roads and draw a traffic line over the road. The traffic line drawn by administrator will act asa traffic signal line. To enable the line drawing feature, we need to select 'Region of interest' item from the 'Analyze' option (Figure-1 c). After that administrator will need to select two points to draw a line that specifies traffic signal.

The system will show output until the last frame of the footage. In background a 'output.mp4' will be generated. The file will be in 'output' folder of 'Resources'. The process will be immediately terminated by clicking 'q'.

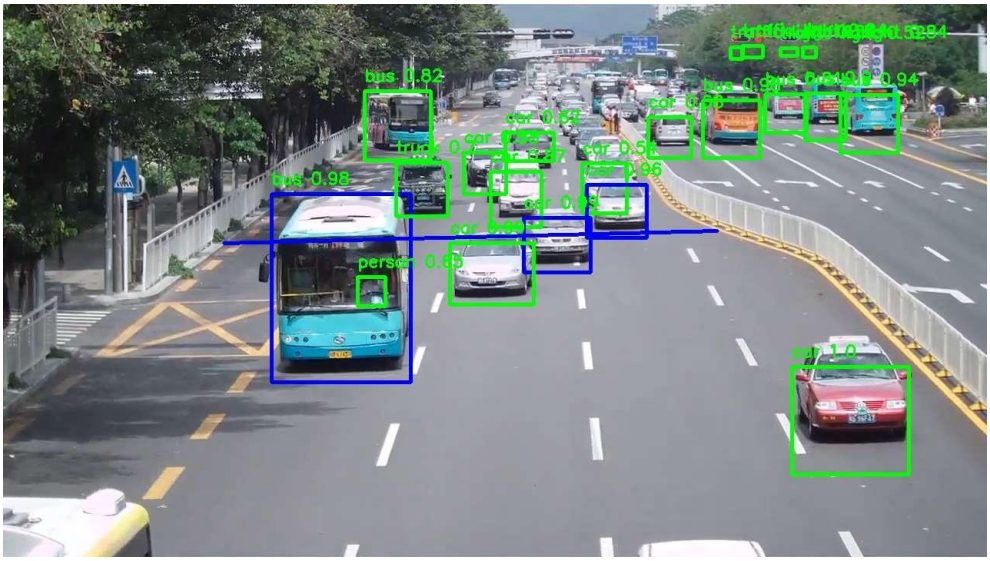

Fig. 1 c: Final Output (on each Frame)

After processing a video footage, the administrator can add another video footage from the initial file manager (Figure-4.2.3 b). If the work is complete the administrator can quit using 'Exit' item from File option.

B. POTHOLES DETECTION

I. Fundamentals

Yolo:
YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy. YOLO is an abbreviation for the term 'You Only Look Once'. This is an algorithm that detects and recognizes various objects in a picture (in real-time). Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images. YOLO algorithm employs convolutional neural networks (CNN) to detect objects in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects. This means that prediction in the entire image is done in a single algorithm run. The CNN is used to predict various class probabilities and bounding boxes simultaneously.

DeepSORT:
This algorithm is used for the tracking of the objects. It will track vehicles and potholes present using camera.

Sense Segmentation:
Tracked vehicles and potholes will be segmented and separated which will be displayed using grid lines of different colours.

II. Design and Implementation

Fig. 2 a: Output of Pothole Detection

The image shows the detection of potholes from the video uploaded by user. The video of the roads can be selected by the users. Those videos include the potholes which are tracked and displayed on the screen using green grid lines. The number present in blue displays the accuracy of the pothole detected by the system.

If the process is complete the system will exit automatically. Otherwise if the user wants to exit the detection system user could exit by simply pressing the 'q' button on the keyboard. This the whole running process of the system.

RESULTS AND DISCUSSION

The Potholes and Traffic signal violation detection system is a ML based application. In this application we have successfully implemented the detection of violating vehicles and potholes on road in a video. The system has proved to provide accurate results of vehicles and potholes. Vehicle detection accuracy has been calculated to 92% accurate. While the potholes detection has reached 95% FPS accuracy.

Table 2 a: Traffic Violation Detection Result:

Input Video	Actual Violating Vehicles	Detected Vehicles	Accuracy
Video 1	4	4	100%

Table 2 b: Potholes Detection Result:

Input Video	Actual Potholes	Detected Potholes	Accuracy
Video 1	7	6	85%

LITERATURE REVIEW

In 2020, Ruben J Franklin, et al. [1] described the detections of traffic violation in the video surveillance is challenging as the number of vehicles on the road and traffic rules are depended on the different area of the road and timings. This paper proposes that the YOLOv3 algorithm is suitable for traffic violation detection.

In 2020, J. Xiaohui Yang, Zeyu Gao, et al. [10] proposed that potholes are a structural damage to the road with hollow which can cause severe traffic accidents and impact road efficiency. In this paper, we propose an efficient pothole detection system using deep learning algorithms which can detect potholes on the road automatically. Four models are trained and tested with preprocessed dataset, including YOLO V3, SSD, HOG with SVM and Faster R-CNN.

In 2021, Rui Xu, Yidong Chen, Xiaoqiang Chen, Si Chen, et al. [2] proposed that due to the limited road resources and the ever-increasing number of vehicles and persons, more frequent traffic violations and higher management costs have resulted. It is crucial to propose a more intelligent and less cost scheme to solve the traffic management problem. In this paper, we design and implement a vehicle violation detection system based on deep learning, which includes the detection, tracking and recognition of vehicles.

In 2019, Brhanu M. Gebregeorgis, Dipti K. Sarmah, et al. [3] , proposed to develop a smart traffic light controlling system that can switch the traffic lights automatically and detects traffic violation such as lane violation, stop line violation and red light violation. The proposed system works 24 hours; in the daytime the system calculates the density of the vehicles and in the night-time the system calculates the number of vehicles.

In 2021, P. S. Ezekiel, et al. [4] presents a smart system for potholes detection using computer vision with transfer learning. The system starts by acquiring a pothole images as data, preprocessing the data by creating image annotation and image augmentation on the pothole images. We also created sub directories by creating called images and annotation where we placed our training images in the image folder and the annotated files (which was generated in Xml format) into the annotation folder that we created. We then train our model using transfer learning.

CONCLUSION

The designed algorithm was effectively able to detect the type of violation specified on this project which are denying traffic signal. The convergence of detection for the traffic violation mentioned is dissimilar, since it has a different threshold condition. The system provides detection for traffic signal violation. Further, the system is able to process one data at a time. Also, the program runtime is somewhat slow, and can be improved by using a computer with high speed processor specifications or GPU. Future research about the application of the designed algorithm for other advanced image processing techniques. Since, this may improve the program runtime of the system by neglecting other unnecessary steps done in a background difference method. A computer vision algorithm may be done instead to provide more intelligence in the system. Our future plan is to implement the number plate detection with OCR support to make this system more robust.

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