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Deep Learning based smart traffic light system using Image Processing with YOLO v7

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***Abstract*— India is home to 10% of all traffic deaths worldwide and has the second-largest road network in the world. Moreover, in smart cities, traffic congestion, pollutants, and noise pollution have increased due to a constant rise in vehicle kinds, technical problems with traffic signal management equipment, and inefficient road traffic management. Despite the fact that current traffic control systems rely on fixed time-based techniques, conventional traffic control systems are unable to manage the complicated traffic flow at junctions. Roadblocks increase mileage, increase transport costs, and pollute the air in addition to adding to the driver's stress and further delays. Therefore, we designed a smart traffic light management system employing the recently launched YOLO V7. The new version V7 of the YOLO algorithm outperforms all previous object detection models in both speed and accuracy. As it is the fastest and most accurate real-time object detection model hence it is the best algorithm to deploy in traffic controlling system. YOLO V7 is +120% faster than other previous models and shows the best speed to accuracy balance.**

Keywords*— *YOLO V7; CNN; Computer Vision.

I. INTRODUCTION

Due to the unchecked increase in vehicle traffic in the modern world, a snarl of traffic has turn into a frenzied activity. The quantity of vehicles on the road each day greatly increases and thus causing a variety of problems. Though we have installed traffic control system like traditional traffic light systems are becoming inefficient in controlling the ever-growing traffic on the roads. In India, traffic congestion costs 1.47 lakh corer annually, according to a Boston Consulting Group analysis from 2018.

Numerous studies have been carried out and is presently ongoing on the efficient traffic controlling systems. The development of intelligent traffic signal systems is one of the main areas of research. Therefore, we designed the deep learning based smart control of traffic light system using image processing with YOLO V7 [3].YOLO V7 is the most powerful object detection algorithm in 2022 as it is the newly launched version of YOLO architecture. It already becomes the industry standard for object detection surpassing the previous version YOLO V4. We will briefly go over the fundamentals of YOLO V7's operation and how it will be the greatest object detecting algorithm in this essay. After that we will discuss the methodology to implement this algorithm in traffic light control system and its advantages.

This paper is divided into VII sections. First section is introduction. II section describes the various conventional traffic systems used today. III section discusses the general introduction and working of YOLO V7. Section IV describes the basic image detection strategies. Section V discusses the proposed methodology and working of the model. Section VI shows implementation and results. Section VII is the conclusion.

II. CONVENTIONAL TRAFFIC CONTROL STSTEM AND THEIR DISADVANTAGES

The currently employed standard techniques are as follow.

A. Manual Controlling

Calls for a person. Being able to direct traffic. The designated purpose of the traffic laws is a necessary region for traffic control. A sign is carried by the traffic police. To regulate traffic, use a board, sign light, and a whistle [3].

DISADVANTAGES: - Laborious, frequent human errors compromises the controllability of the traffic.

B. Automatic Controlling

Timers and other timing devices operate automatic traffic lights. Electromagnetic sensors. Fixed number used in traffic lights the timer after loading. Automatically turn on the lights Depending on the timer's value, ON and OFF. Whenever utilizing electrical sensors, which will record both the vehicle's availability and signals at every phase, with the lights are corresponding to the signal switch ON and OFF automatically [3].

DISADVANTAGES: - Excessive traffic delay due to technical glitches that occurs frequently.

III. YOLO V7: GENERAL INTRODUCTION AND WORKING

You Only Look Once, or YOLO, is a Real-time object identification technique which is widely used. In 2016, the initial version of the YOLO object detector was made available. Santosh Divvala, Ali Farhadi, and Joseph Redmon were the architects of it. When it was released, this architecture was cutting edge for real-time computer vision applications since it was quicker than other object detectors.

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YOLOv7 dramatically improves real-time object detection accuracy while lowering inference costs. As the standards previously shown, YOLOv7 effectively outperforms other renowned item detectors by reducing about 40% of the parameters and 50% of the computation required for modern real-time object detections. This allows it to perform inferences more quickly and with higher detection accuracy. Now let's take a look of architecture of YOLO V7. The YOLOv7 design is built on the YOLOv4, Scaled YOLOv4, and YOLO-R YOLO model architectures from before. The key elements will be briefly discussed in the sections that follow.

a) E-ELAN: -In the YOLO v7 backbone the Extended Efficient Layer Aggregation Network (E-ELAN) stands for the computing block. The E-ELAN architecture of YOLOv7 enables the model to learn more effectively while keeping the original gradient route by using "expand, shuffle, and merge cardinality".

b) Scaling of Compound Models: - The basic goal of modelling scale is to modify important model characteristics in order to produce models that are suitable for various application criteria. As an example, modelling scale can improve the model's resolution, depth, and width (number of stages) (input image size).

c) Planned Re-parametrized Convolution: - The planned re-parameterized convolution architecture in YOLOv7 employs RepConv without Identical relationship (RepConvN). When re-parameterized convolution is used to replace a convolutional layer with residual or concatenation, the goal is to prevent there from being an identity link.

So, to summarise, we may say that a YOLO architecture consists of a head, a neck, and a backbone. The head is where the projected model results in YOLOv7, which is not constrained to just one head because it was influenced by Deep Monitoring, a method frequently utilised for deep learning neural networks training. The lead head is in charge of producing the ultimate product, while the auxiliary head is utilized to support middle-layer training. Now we will look upon the basic object detection strategies.

IV. Basic Image Detection Strategies and Process

We are considering Image processing as it is the best method to continue the process of real-time data and provides precise results, which contributes to basing traffic signal timing on vehicle density. Images of the lane are taken using a web camcorder, and are then processed in five steps: edge recognition, picture scaling, image enhancement, and RGB to grey conversion. Under this system, a camcorder captures a reference image of an empty lane and utilises an image matching method to assign time. The quantity of vehicles is calculated using image processing methods. The centroid of the red and blue light is founded, and green time is determined depending on the number of vehicles. One of the innovative methods for identifying ambulances is image segmentation based on colour. The ambulance's value is below a predetermined amount, Red and blue light's centroid are both located on the same line, the ambulance is detected. The several strategies for detecting edges are available, including crossing zero, Predict, LOG, Robert, Canny, and Sober. We used Canny Edge detection, which produces more accurate and reliable results than additional methods of edge detection. A comparison of distinct edge observation technique is shown in figure 1.

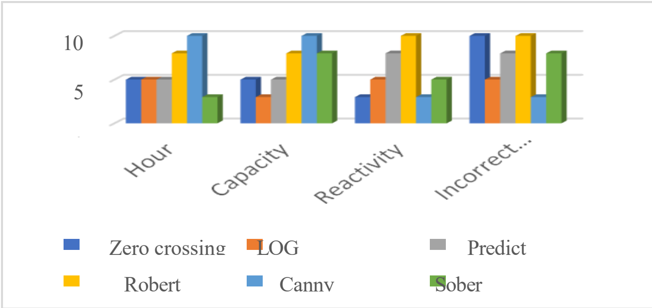

Fig.1. Scanning of distinct edge observation technique

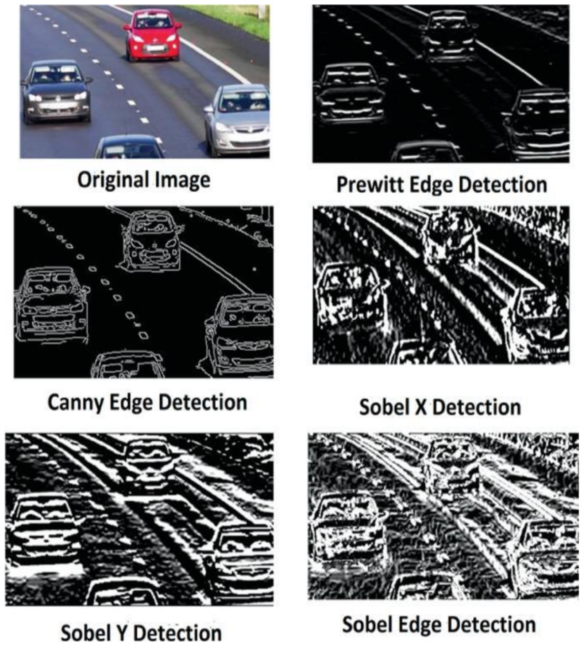

Fig . 2. Various Image processing Techniques

V. Proposed Methodology of Traffic Light System

For running object detection code in computer vision application, we require edge AI, which allows Edge computing with Machine learning. As an illustration, consider the Intel Neural Compute Stick and the Nvidia Jetson AI Edge devices.. Python and PyCharm are used to implement the suggested system. The project's goal is to cut down on the amount of time wasted in idle lanes. Two sections make up the entire system [5].

1. Information about image matching
2. Allocating time

The portion that contains image matching data uses image processing techniques in the PYCHARM version to compare exemplar pictures, collected pictures and calculate their similarity in terms of a percentage. The Traffic Light and Timer Allocation systems are used in the Time Allocation segment. The below given figure 3 illustrates the whole process.

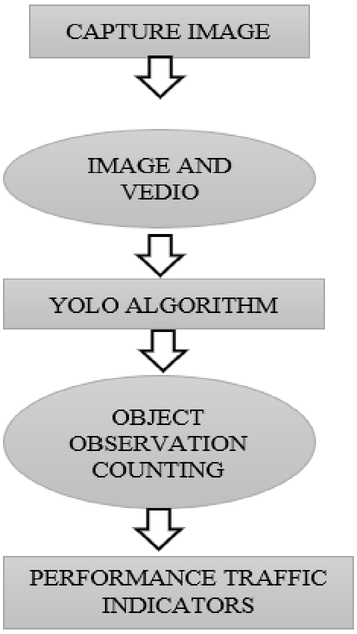

Fig. 3. Methodology Implementation

a) Capture Image: In this step image extraction is done from captured source in an order to convert it to a digital image and after that it is directly processed by YOLO V7 to analyze the traffic.

b) Image and Video: In this step images are taken from real time videos and detect the objects in the images and after that it is processed by same YOLO V7 to analyze the traffic.

c) Yolo V7 Algorithm: Now the YOLO V7 analyze the traffic on the basis of provided images from the image and video capturing devices and gives the results.

d) Object observation Counting: Final count of vehicles is generated on which the programme decides what colour of light will be displayed on traffic lights.

e) Performance traffic indicators: Finally, the lights are shown on the traffic light according to the situation (intensity of traffic). The whole process becomes very fast due to YOLO v7 algorithm as it detects the objects very fast and with high accuracy.[10]

VI. Results

Image and video datasets are selected from cameras monitoring traffic. To produce remarkable datasets for the model’s effective training it crucial to select high quality, class-balanced photos. Thus, better metrics for performance are reached in order to extract the features from the picture and video datasets, CSP darknet-53 is used for object detection. Application of the YOLO v7 object identification technique using a neural network for traffic signal application. For the training of the model, a bespoke dataset comprising photos and videos of India road traffic with several distinct objects—including automobiles, trucks, two- wheelers, buses, micro trucks, people, bicycles, vehicles, and vans—is taken into consideration. A collection of images and videos was created in bad weather. At the intersection, a camera will be put in place for the purpose of taking pictures of the lane's real-time traffic. The acquired image is contrasted with the earlier, vacant lane image that was also captured. The image processing methods outlined above are used to establish the traffic density. Thus, we assign time for lanes and manage traffic lights based on percentage matching. To the traffic signal controller is provided the image percentage match. The time for each lane is determined by the controller based on the percentage match. The results are shown in figure 4 with python codes in background. From the results we can say that this proposed model works very well with high accuracy of 92%. Real time decisions are taken very fast and training and testing data size is 56%.

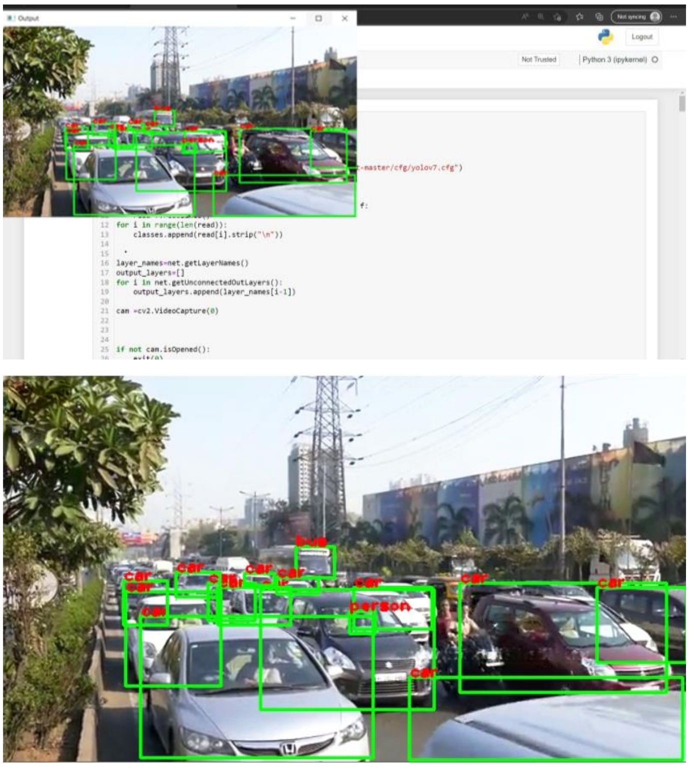

Fig. 4. Outcomes of Image Processing

TABLE I. Table Type Styles

Parameter	YOLOv4	YOLOv5	YOLOv7
Size	640	640	640
Frame per second	61	99	120
Accuracy	65.7%	86.4%	92%
FLOPs	142.8G	218.8G	360.0G

VII. Conclusion

Finally, we can say that the proposed traffic light system with YOLO V7 architecture works with 92% accuracy in managing and controlling the traffic. It is found that YOLO V7 outperforms all earlier item detectors across all conditions. The speed range starts at 5 FPS. to 160 FPS with highest accuracy compared to other object detector models. There are other application also of this algorithm in which security and surveillance, application in AI retail analytics, manufacturing and energy, designing of autonomous vehicles, visual AI in healthcare are among the most popular application. So, it can also be used in future applications. In YOLO v7, for training and testing data was use 56% Detection accuracy of vehicle is around 92%.

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