Traffic control system by using Image Processing

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Abstract - *Object detection is very important in intelligent transport systems implementation. Counting the number of vehicles can help in controlling the traffic flow. Intelligent transportation systems are required to control the traffic automatically and seamlessly. There are many algorithms for object detection but are not very accurate as compared to the state-of-the-art algorithm YOLO. The YOLO (You only look once) algorithm is used to predict the class of an object which is based on regression and it predicts bounding box and classes for complete image in a single iteration. The proposed system is a web-based application which will be depending on a camera for video input. The video will be processed and will be classified based on classes. The proposed system calculates the number of vehicles. The count of vehicles will be used to change traffic lights on traffic signals. Different locations and variations of roads are processed to check the accuracy and efficiency of the system. The test results indicate that our system works efficiently in sufficient ambient light. The system is simple and very easy to implement.*

***Key Words*: Object detection, Image processing, smart vehicle detection, YOLO, Convolutional neural network**

1. INTRODUCTION

In this growing world, traffic is becoming a very big problem. For this we need a smart solution. Today countries like Russia, USA and Japan are also facing a traffic problem. In India increasing population is a very big reason behind traffic problems. With the increasing population, there is a surge in vehicle population too which results in traffic congestion. For instance, Mumbai is recorded as the most traffic-congested city in India. Also, people prefer private vehicles over government transport for commutation.

In smart Cities, the Intelligent Transport System (ITS) Plays vital role in solving Traffic Congestion. ITS provides smart and advanced solutions for transport and traffic management. It plays a very important role in traffic surveillance systems. The video footage can be used for identifying the causes of road accidents, traffic rules violations and it also helps in vehicle counting. Rising traffic congestion is an inescapable condition in the smart cities. So they are starting to adopt new technologies to solve these problems by using ITS.

2. RELATED WORK

Computer vision is the basis for a lot of traffic management smart systems. Major research and work is already done in this field of study. Many different intelligent transport systems have already been built.

In [1] an improved vehicle detection using YOLO V3 is implemented. It ignores the traditional manual feature selection by using depth convolution features. Low light is not a very big issue in this.

In [2] YOLO algorithm based traffic counting system is built. It counts the traffic flow and then analyses if the count is accurate. This paper analyses the correctness and the overall efficiency of the algorithm.

In [3] Mario Gluhaković and Marijan Herceg have developed a system which will detect a vehicle running in the wrong lane. This system will avoid any potential collision. It uses the YOLO algorithm to detect vehicles in the opposite lane.

In [4] an aerial vehicle detection system is developed. In aerial images pixel size is small therefore the conventional algorithms usually get confused. But the algorithm in this algorithm is able to detect vehicles accurately.

In [5] this paper the system aims to reduce the number of accidents and also reduce frequent traffic jams. The YOLO algorithm is used as an accurate centroid tracking algorithm. This system is very easy to implement and simple to use.

3. PROPOSED MODEL

Our proposed model uses the YOLO algorithm for detection of vehicles with classes like, 'Bus', 'Car' 'Truck', 'Bus', 'Person', 'Motorcycle' and 'Bicycle'. The fig -1 shows the architecture of our model. . When the camera gets open it divides the video into frames and forwards the frames to the YOLO algorithm. Each frame is scaled to a

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predetermined size before being fed through the neural network for vehicle recognition. The algorithm generates a vector including the vehicle class, prediction confidence, and bounding box probability..

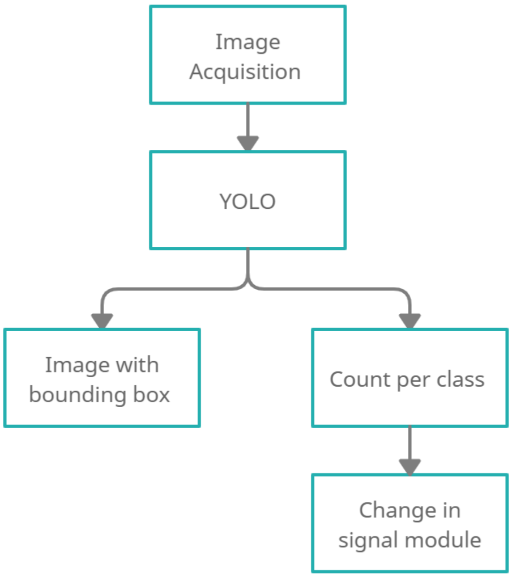

Fig no -1

Following are the steps involved in our model -

- Image acquisition
- Yolo Algorithm
- Calculate timer
- Set a green signal timer.

A. Image Acquisition: The image acquisition is done using a web camera. The camera sends the frames of traffic images to the algorithm. The Image Acquisition works autonomously. Camera captures the image and gets closed and opened on its own. To capture the image we used the OpenCv library of python. The width of the video frame in pixels is determined by the YOLO v4 algorithm's configuration files, and it is 416.

B. Yolo Algorithm:

Yolo stands for you only once. Vehicle detection is done through a yolo algorithm where bounding boxes will detect the vehicles and the algorithm will return the count of vehicles per class like 'Car', 'Bus', 'Truck', 'Bus', 'Motorcycle' and 'Bicycle'. DarkNet and YOLO are popular methods we used for bounding boxes. YOLO outperforms algorithms like Mask-RCNN in real-time applications and is the current state of the art. YOLO comes in a variety of forms [1]. We utilized the most recent YOLOv4 version in this model.. The advantage of yolo is it doesn't look at the image more than once and sends back the detected object class number, bounding boxes and probability as shown in fig below. The given figure

Shows the example of yolo giving output of score, bounding boxes and class. Here we are considering threshold value as 0.6 so the score where score is more than 0.6 will be considered. It separates the photos into SxS grid cells first. Bounding boxes B are associated with each cell. If there are C classes, the total bounding boxes will be SxSxB, and the characteristics of each box will be (5+C). As a result, it will only take into account the box with a confidence score of greater than 0.6 and the class name. All surgeries are conducted in a single phase. To get around this, a technique known as non-max suppression is applied. During this procedure, the box with the greatest confidence score is chosen first. Then any boxes that overlap more than a threshold value will be removed. This method only keeps one box per object.

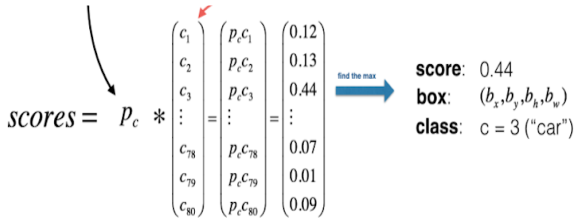

Fig no-2

After passing the image frame from yolo it gives output shown in Fig No-3.

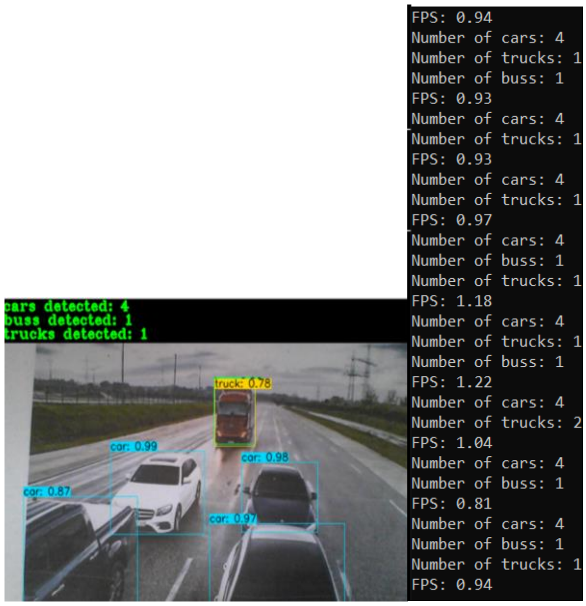

Fig no-3 Example of yolo algorithm output

To extract the characteristics in YOLOv4, we employed a new deeper convolutional neural network (CNN). There are 53 convolutional layers in total.

The pre-trained darknet53 weights that are available on the Internet are utilized to train the YOLO V4 algorithm.

C. Calculate timer:

In this paper, the timer rule is developed for each type of class like 'Car', 'Bus', 'Truck', 'Bus', 'Motorcycle' and 'Bicycle'. As the yolo algorithm returns the count of each detected class in real time. We generate the timer for the green signal of the traffic model. Here we divided it into the below type.

-Big Vehicles = Bus, Truck

-Medium Vehicles = Car

-Small Vehicles = Motorcycle, Bicycle.

-Pedestrian= Person

Class	Green signal timer	Yellow signal timer
Big Vehicles	4 sec	3 sec
Medium Vehicle	3 sec	3 sec
Small Vehicles	2 sec	3 sec
Person	6 sec	3 sec
Big Vehicles*n	n*4 sec	3 sec
Medium Vehicles	n*3 sec	3 sec
Small Vehicle*n	n*2 sec	3 sec
n*Person (n<4)	6 sec	3 sec
n*Person (3<n<7)	6*2 sec	3 sec
n*Person(6<n<13)	6*3 sec	3 sec
No object	0 sec	3 sec

The yellow timer we have set is default for all classes. While the Green timer is calculated based on the above rule which we have implemented in our algorithm. The final timer value is calculated from the sum of timers of all classes which are calculated individually based on table no -1.

D. Set green Signal Timer -

The signal model simulation is created using the turtle library. The timer value created is passed to the model function and the green timer changes accordingly. The Fig no-4 shows the output example of it.

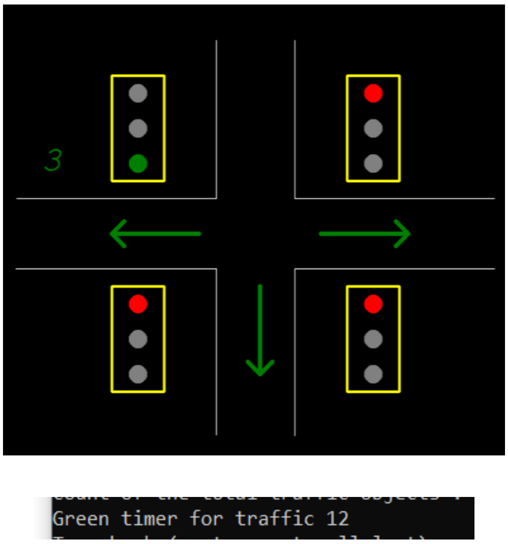

Fig no-4 Simulation of traffic signal

As after the green timer comes down to zero, the yellow timer gets started and when the yellow timer gets zero the camera opens automatically and captures the image of the other lane. This process works in a loop on its own. The arrow shows the direction where traffic is going while the timer is also shown.

RESULT AND DISCUSSION:-

A desktop was used to test the proposed system for smart traffic control. Two tests were run, one to see if the traffic light model was working properly, and another to see if traffic count estimation is being done correctly. The tests were performed on 92 custom sample input images and were done in both daytime and nighttime.

The results of test- 1,2,3 are shown in table-2,3,4 respectively.

VEHICLE COUNT AND TIMER

Count of Vehicles	Timer Value
2 Cars, 1 Truck	(2*3)+(1*4)=10 sec
5 Cars, 2 Bicycle	(5*3) +(2*2)= 19 sec
3 Bus, 1 motorcycle, 4 cars	(3*4) +(1*2)+(4*3)= 24 sec

Table no-2

During the test-2, the actual count of vehicles (AC) and predicted count of vehicles (PC) were taken into consideration and based on this we calculated the accuracy of our model in day and night. The results are below

TRAFFIC COUNT AND ACCURACY OF SYSTEM

Test case	Class of object	AC	PC	Accuracy
Day time	Car	81	76	93.8%
	Truck	44	38	86.3%
	Bus	32	30	93.7%
	Motorcycle	89	84	94.4%
	Bicycle	22	21	95.4%
	Person	102	99	97.1%
Night time	Car	81	59	72.7%
	Truck	44	29	65.9%
	Bus	32	20	62.5%
	Motorcycle	89	56	62.9%
	Bicycle	22	14	63.6%
	Person	102	78	76.5%

Table No-3

From above table 3, it has been observed our system gives accuracy of 93.48% in avg for day time while for night time it's around 67.35% for night time.

3. CONCLUSIONS

We have proposed an intelligent transport system to tackle the problems faced by every other person due to traffic conjunction. The increase in efficiency and effectiveness of the modern object detection algorithms has benefited our algorithm. In our paper we are proposing a new system which can count the number of vehicles by utilizing the YOLO (You Only Look Once) algorithm. The first step of the system architecture consists of the Image acquisition. The YOLO is divided in two steps, one the construction of bounding boxes and second is the calculation of vehicles per class. Further the change in signal module is the final step which is dependent on the previous process of vehicle counting. In the nighttime the algorithm is not as accurate as in daytime. Hence, the future scope of the algorithm is to tackle this problem of low accuracy in low light conditions.

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