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ATMOS: Advanced Traffic Management and Optimizing System

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Abstract—*In this project we would be making a smart way of managing the traffic using computer vision and object detection for performing various processes for smooth flow of traffic. By using the OpenCV library, and YoloV3 algorithm, we are trying to control the traffic lights at the junctions by finding the vehicle density at the signal. The system would also be able to track the vehicles that are breaking the signal and the details would be transferred to the authorities. Majority of the code is written in Python using various libraries and the dataset that will be used is an open-source large-scale object detection, segmentation, and captioning dataset. This project will ensure effective and accurate management of traffic and will help in making traffic lights more efficient.*

Index Terms*—Computer Vision, YoloV3, Darknet, Traffic management, Euclidean Distance.*

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I. INTRODUCTION

The presence of technology is prominent in almost every aspect of modern day's systems and fundamentals. Owing to this, automation is no more a luxury but a requirement. Today, an individual spends at least 8-10 days stuck in traffic per year. This takes up a lot of unproductive time as well as contributes to the fuel wastage which is an important problem in today's world.

The goal of building such ML based systems is to minimize human intervention and let machines which are run at the commands of electrons take over for the most basic tasks. In this implementation, concepts of Image processing are inculcated along with Deep learning playing the governing role of the brains of the system.

Image processing brings along its own set of problems such as dimensionality. To deal with this aspect, we will be applying dimensionality reduction techniques, one of which is the wavelet subband theory. To apply image processing, the OpenCV library needs to be brought into the picture.

OpenCV has a set of algorithms and approaches such as PCA (Principal Component Analysis) which will be used to improve the efficiency of the model.

You Only Look Once, Version 3 (YOLOv3) is a real-time object detection algorithm that recognizes specific things in films, live feeds, and photos. To detect an item, YOLO uses features learned by a deep convolutional neural network. Joseph Redmon and Ali Farhadi produced the first three versions of YOLO.YOLOv3 is major algorithm we are using to detect vehicles and object detection.

The link between the vehicle recognition and the actuation part is the neural which literally acts as the intelligence of the system. A hybridized neural network would be employed which combines local image sampling, a self-organizing map (SOM) neural network, and a convolutional neural network**.**

Once the neural network and the input images are taken care of, it will be connected to the hardware to actuate the software created.

II. LITERATURE REVIEW

We researched multiple research papers to confirm that our project is practical and to explore the various methods in which it might be implemented. These papers gave us insights, which in turn provided us with a clear direction and plan of execution for our project. A few research articles had succeeded in traffic control by using inductive loops, which sensed a vehicle passing in their area and added to the total number of units on the road at the time. This information was then compared to other routes and data from other crossroads roads, and the traffic signal was adjusted accordingly [2]. C. S. Asha and A. V. Narasimhadhan published an article [3] that explained how the YOLO (you only look once) framework could be used to count the number of automobiles using a video stream. The type of vehicle in the frame can also be classified using this method. The internet of things can be employed in vehicle detection, according to a paper by Janahan, Senthil Kumar &Murugappan, Veeramanickam&Sahayadhas, Arun & Narayanan, Kumar & R, Anandan& Shaik, Javed. A remote application and a KNN algorithm are used in the research project to detect the presence of automobiles and regulate traffic using many IR sensors placed around the roads. For remote control, an android application was utilized, and the rest was handled by microcontrollers and their server. We were able to better grasp YOLO after reading the study [4] by Song, H., Liang, H., and Li, H.: Vision-based vehicle recognition and counting system utilizing deep learning in highway scenes. This study examined how to calculate a vehicle's speed on the highway in order to prevent speed limit infractions. The same principle can be applied to a regular city street to guarantee that people follow all traffic regulations in order to stay safe. The analysis of these and other works led us to the conclusion that the YOLO framework should be used for picture detection.

III. METHODOLOGY/EXPERIMENTAL

A. Block Diagram

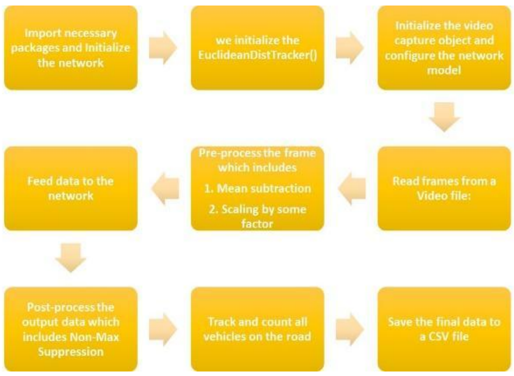

Fig. 1 Flowchart explaining the algorithm.

The euclidean distance tracker was started by importing the appropriate packages and initializing the network. The length of a line segment between two locations in Euclidean space is known as the Euclidean distance in mathematics. In addition, we set up the video capture object, network, and network model to read frames from the video file and pre-process them with mean subtraction and scaling by a factor. The data is then sent into the network, where it is post-processed using Non max suppression. The data is then tracked, vehicles are counted, and the final data is recorded in a CSV file.

We've picked a variety of automobiles and assigned them a certain time. i.e. how much time they will require to cross the signal. Assuming that a car takes 5 seconds to travel, we estimated the number of cars, multiplied by cartime, and divided by the number of lanes. allowing us to get the time we need for a green signal.

B. Theory

YOLO v3 is based on a Darknet variation that used to have a 53-layer network trained on Imagenet. For detection, 53 more layers are put on top of it, giving YOLO v3 a 106-layer fully convolutional underlying architecture. This is the cause of YOLO v3's slower performance when compared to YOLO v2. This is how YOLO's architecture currently looks.

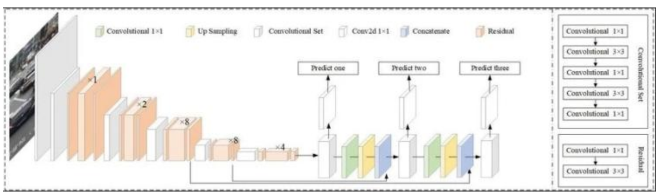

Fig.2 Representation of how the images are screened.

The YOLOv3 feature detector's architecture was influenced by well-known architectures such as ResNet and FPN (Feature Pyramid Network). The YOLOv3 feature detector, known as Darknet-53, contained 52 convolutions with skip connections, similar toResNet, and a total of three prediction heads, similar to FPN, allowing YOLOv3 to analyse images at varied spatial compressions.

Darknet-53 is more powerful than Darknet-19 and more efficient than competitor backbones because it includes 53 convolutional layers instead of the previous 19 on YoloV2 (ResNet-101 or ResNet-152).

Backbone	Top-1	Top-5	Ops	BFLOP/s	FPS
Darknet-19	74.1	91.8	7.29	1246	**171**
ResNet-101	77.1	93.7	19.7	1039	53
ResNet-152	**77.6**	**93.8**	29.4	1090	37
Darknet-53	77.2	**93.8**	18.7	**1457**	78

Fig. 3: Comparison of various training models

*In the chart we can see that*Darknet-52 is 1.5 times quicker than ResNet101, as shown in the graph. Because it is still as precise as ResNet-152 while being two times faster, the shown accuracy does not imply any trade-off between accuracy and speed between Darknet backbones.

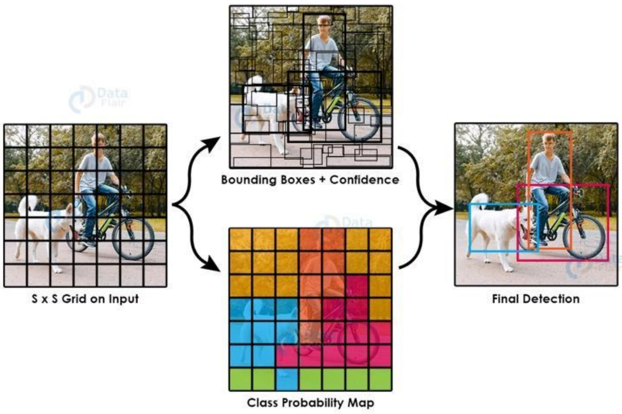

Fig. 4: Demonstration of how YOLO divides and boxes the object.

IV. RESULTS AND DISCUSSIONS

We have Successfully detected and differentiated different types of vehicles. The program is also able to count the number of vehicles waiting at the traffic signal at a given time. With the help of this project, we will be able to reduce the waiting time of the vehicles at the signal. The static system(with fixed green signal time) allows less number of vehicles to pass than the proposed system. By changing the green signal time based on the density present at the signal this can be achieved.This ensures that a direction with more density of vehicles is allotted a green signal for longer duration as compared to the direction with lesser traffic.

Fig 5: The vehicle count implemented on real time detection using YOLO

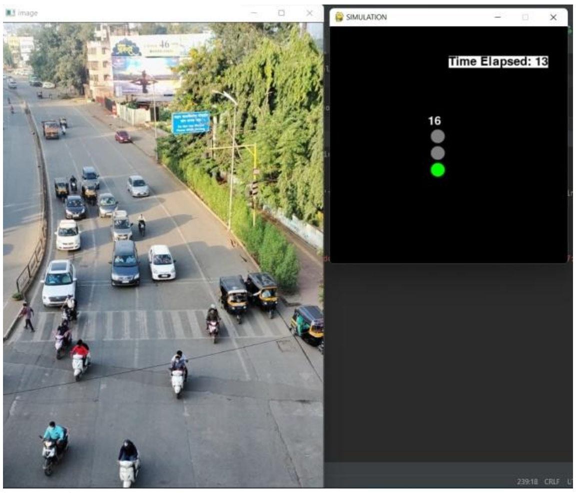

Fig 6: The feed of the security camera along with the signal implementation.

V. LIMITATIONS

The initial cost of this project is considerable because of the high expense of installing and maintaining cameras and other devices. This type of technology will necessitate a significant investment. The other constraint is that visibility on the road decreases during rainy seasons or fog, which has a direct impact on the accuracy of the traffic count, creating mistakes in traffic estimates. In addition, appropriate streetlights are essential for the system to function properly at night. Because a human life is on the line, even a minor defect in the system can result in an accident, the design of this system must be flawless. There is no specific lane for each kind of vehicle so it becomes difficult to get the exact number of vehicles. This is because the two-wheelers are not seen if a heavy truck is in the front. This will reduce the accuracy of the count of vehicles.

VI. FUTURE SCOPE

Every day, cameras mounted on traffic signals collect thousands of hours of footage that contains extremely useful information and can be utilized to minimize street congestion. It is possible to develop predictions about traffic scenarios using video footage data, a data set of traffic films, and machine learning algorithms. Pattern recognition can be used to identify vehicle types, count the number of vehicles on the road, and classify light and heavy vehicles. This would increase the system's ability to predict traffic on each street and adjust traffic lights accordingly to reduce congestion. This system can also be implemented to identify vehicles running red lights. An ambulance or a fire truck can be recognized and can be given a way to go more quickly with the help of this advanced traffic management system.

VII. CONCLUSION

Traffic management is accomplished by adjusting the time of the traffic light based on the number of vehicles on the road. As the amount of data collected grows, the proposed model is projected to perform better. It will be feasible to make more accurate forecasts. We will be able to automate traffic using advanced technologies such as machine learning and computer vision. This project will also help in reducing the unwanted delays, congestion and waiting time of the cars which in turn will help in reducing the fuel consumption and the pollution caused by the vehicles. This system can be implemented with the CCTV cameras in major cities for better traffic management.

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