2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE)

Real Time Traffic Management Using Machine Learning

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2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE) 978-1-7281-4142-8/20/$31.00 ©2020 IEEE 10.1109/ic-ETITE47903.2020.462

Abstract—The congestion of vehicles on the road is increasing day by day and also the management of such large traffic by traditional approach isn't adequate enough. In today's scenario the traditional approach works efficiently only if the count is sparse, as the density of vehicles on a particular side of road increases or if the traffic is comparatively larger on one side than other side in such case the approach fails. Hence, we aim to redesign the traffic signal system that is static switching to signal switching, which can performs real-time signal monitoring and handling. So, in this project the switching time of signal will be decided based on real time image detection with good accuracy in dense traffic. This practice can prove its most effectiveness in releasing the congested traffic at an efficient and faster rate.

Keywords— Traffic Congestion, Vehicle Count, image Processing, Machine Learning.

I. INTRODUCTION

People in today's era usually have tendency of using their own private vehicles for commutation rather than using public or pooled means of transport and this results in large number of private vehicles on road. This endless increasing number of vehicles on road gives rise to many problems amongst them traffic congestion tops in every aspect. In such scenario one cannot restrict individual to limit the usage of their private vehicles but what we can do is at least manage traffic flow in a way that it doesn't alleviate congestion issues.

There are many projects emerging in order to convert the current transport system of cities to 'Smart system' and there are many initiatives under this, one of this is Intelligent Transport System. Many initiatives were taken to design a system that can perform real-time monitoring of traffic signals i.e. the traffic signal switching time will not be predefined o n e, instead the switching time will depend on the count of vehicles on each side of the road. This process of getting the count of vehicle on the road can be achieved using various detection techniques.

Our aim is to design and develop a miniature to depict the current road situation along with monitoring and handling the traffic issues. Hence to proceed with this project we are using a pre-trained model YOLO to perform the task of object detection. The pretrained model YOLO uses OpenCV for object detection along with multiple foreground and background subtraction and removal of noise from the input image. The CCTV cameras that are being used for surveillance purpose can be made use to capturing the footage of the road, this image will be passed to the pretrained model as input image. To do so each side of the road will be divided into particular frames of same height and width for capturing the image. The count obtained from the image is the fed to the Raspberry board. As per the count obtained, switching time will be assigned for each side of road. The program will initially check if the count of vehicle in all frame is approximately same then the switching will remain at its predefined regular interval for all sides of signal, the real-time switching for the signal will be performed if the count of vehicles in all fames varies as threshold difference which be provided.

II. LITERATURE SURVEY

In literature[1], In this research object Detection and Tracking, Gaussian Mixture model along with Kalman filter were used to perform the task named object detection, to do so video input from signal were taken for processing. The input video taken as example was by considering both day and night time traffic scenario and its limitations. This research used (.mov) format video as input with frame rate of 25 fps and resolution of 640 x 480. Data was taken from top of a pedestrian bridge with static camera position. The detected image was marked with blob area where the blob area corresponds to the object detected as vehicle. The image detected with blob forms a colorful bounding box around itself representing the detected object, whereas the image without blob area is left unbounded. The system created was validated for vehicle detection using Receiver Characteristic analysis.

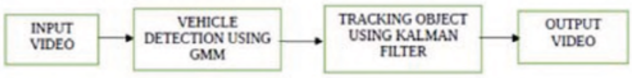

Fig 2.1 Vehicle Detection & Tracking

In literature [2], As the current available extraction methods are not so efficient for processing the traffic basis data, an efficient acquisition method need to be presented in order to process the traffic condition. The method used in this

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paper is based on improved Kalman filter and gaussian to resolve the conflict of multi-moving vehicle targets detection. Also heuristics improvement method was applied to improve the efficiency of detection. The method proposed can effectively improve the noise interference and also possess the capability of detecting vehicle from continuous video frame. The main concept presented in this paper was related to no missing, no re-inspection, error detection while detecting the vehicle from the captured images.

In literature [3], The paper presented mainly focuses on the basic idea of creating an environment that uses low-cost camera and its functioning was on the basis of camera-based algorithm in order to process and control the traffic flow on the road. The vehicle detection form the image captured was done by subtracting the background and foreground images. Tracking of vehicles is done with the help of Kalman. The algorithm proves its efficiency by maintaining its detection accuracy in day as well as night time from the videos acquired from CCTV camera and IR camera. Here, the vehicle detection, counting and tracking was done with the help of computer vision. Also to clearly discern the vehicle from background, BLOB analysis was performed. The model had enlarged its scope in detection and is more flexible in terms of cluster covariance.

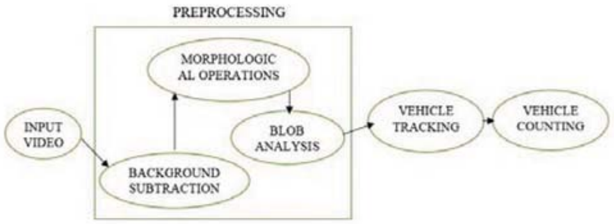


Fig 2.2 Vehicle Locating & Counting

In literature [4], The paper proposed an idea of creating an automated system to control the traffic signal and its flow management with the help of multiple CCTV cameras which are connected all over the internet. To execute this task the whole process is divided in to two sub-tasks: Vehicle Detection System and Traffic Scheduling Algorithm. Vehicle Detection was carried out by using Digital Image Processing and by applying a simple kernel-based Edge Detection and the concepts of Machine Learning was applied to classify the vehicle type into its categories. Scheduling algorithm is designed and optimized by keeping some major points in to consideration such as are low complexity, greater efficiency, and faster process time without compromising on the accuracy of the results. The system designed is extremely efficient and has also proved its beneficiary while using a simple 2MP CCTV camera.

In literature [5], The system designed was with basic components such as CCTV camera, raspberry pi 3 board and a mobile application. The surveillance camera placed at the junction on the road were used in this project to capture the input data of the traffic signals. The captured images data then sent to the server where the data is prepared before being preprocessed by the microcontroller. The vehicles from the images are detected using raspberry pi 3 microcontrollers with the help of image processing and the result of the traffic condition is send to the android-based application via Bluetooth. The information sent to the mobile user has all information regarding the traffic scenarios whether it is dense, sparse or moderate. The mobile user can switch the traffic light via an app also. Thus an authorized user can view all the traffic patterns on mobile phones and monitor the traffic easily at the intersection point on the road.

III. Problem Statement

With the highly rising traffic congestion all around the world, and it's management by traditional approach are not efficient for smooth commutation purpose hence there is a need to come up with a solution which can be globally accepted and would lead for the better management of traffic. In today's traditional approach the signal switches at its predefined regular interval, but the density of vehicles of the road at every signal doesn't remains the same as shown in fig 3.1, hence the static approach fails. Under such scenario, if the signal remains the same to switch at its regular interval then the side of road which is densely populated will always remain completely packed.

As mentioned in above systems designed till date are to getting vehicle count only, so that comparative study and analysis of traffic can be done. This model can work at its best at condition when traffic reaches to its peak, where the management by an individual becomes difficult. So our aim is to design a model, depicting the real-time traffic scenario and performing signal switching as per our criteria and conditions of threshold value.

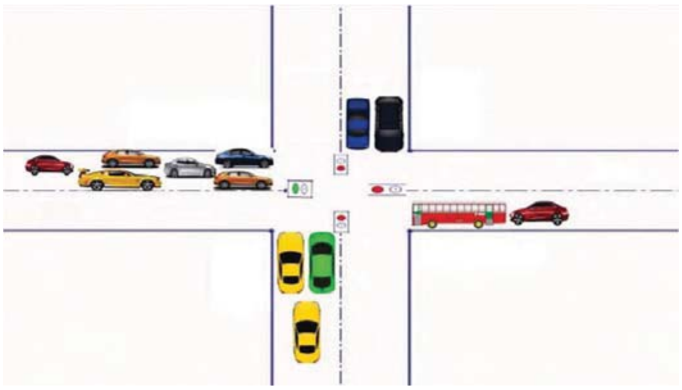


Fig 3.1 Solution for current Traffic scenario

As shown in above diagram, the traffic at LANE 1 is densely populated with vehicles as compared to other three lanes. In normal signal switching method signal switching is done in clockwise manner which result in clogging of vehicles in a particular lane. To overcome the problem of assigning same switching timing for the signal even if the count of vehicles on the road is varying from lane to lane.

IV. Proposed System

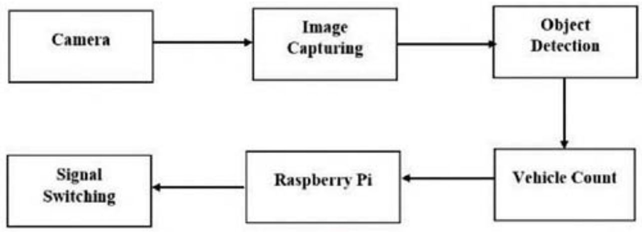


Fig 4.1 Block Diagram of the Proposed System

The model aims to provide a solution for current traffic issue by managing traffic signal on the basis of real time scenario. Here a pretrained model YOLO is used to perform the basic task of object detection, and correspondingly the count of the vehicles are stored in order to process further request of signal processing. Also the model is compatible with almost every type of camera, even the cheaper ones including the normal surveillance camera can be used to capture image at an initial level. Now the captured image will be passed to the model for vehicle detection purpose followed by vehicle counting process as shown in figure 4.1. This whole process of capturing image and detection will be repeated for all four sides of the road using one single camera i.e. pi camera, as pi camera is the most compatible camera for raspberry pi3 board. The camera will be fixed on a rotational motor (servo motor/stepper motor), so that it rotates 360 degree to capture image.

The captured image is then passed to a filter where the region is defined in terms of height and width, only vehicles present in that predefined region are detected and counted. This regions size remains constant for all image being captured. OpenCV is the library that plays important role in object detection, also as and when the object gets detected it forms a rectangular box around the object, so that one can even visually verify that the object detected as vehicle is actually a vehicle only as shown in figure 4.3.

The count obtained from the image obtained from all for side of the road is now passed as input to the raspberry board. The raspberry computes the result by comparing all the count obtained from four different images. The model has some of its fixed threshold value fitted in to it, if the result form the four images is in limit of threshold then simple static switching will be practiced and every signal will be allotted with same switching time, as the traffic on all sides is either sparse or is densely populated by vehicles from all sides. Also in case if the computed result from either of signal crosses the threshold value than dynamic signal switching comes in to action. In dynamic switching the switching time will be assigned on the basis of how densely the road is jammed.

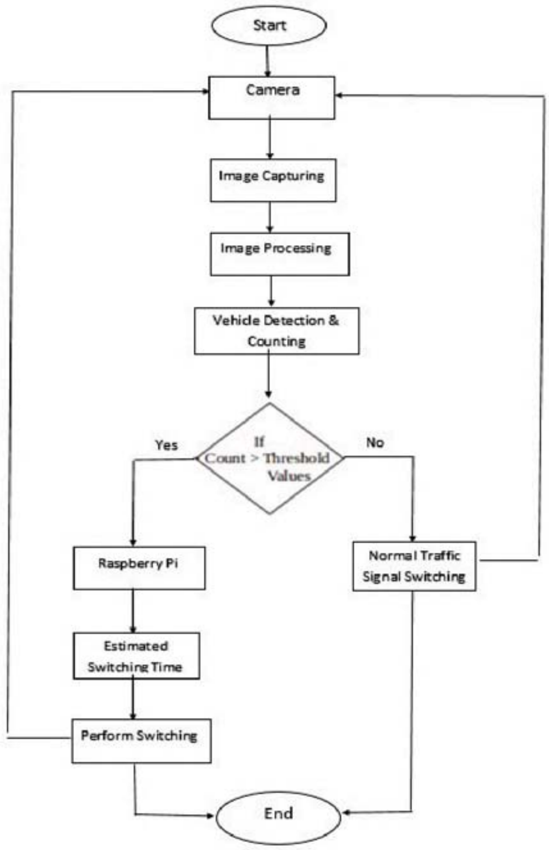
The model is designed keeping the point into consideration that the amount of traffic on all signal does not remains the same then how can threshold value remain the same, hence after few computational processes the model will learn by itself to set threshold value on the basis of how heaped signal is.

The figures 4.2 and 4.3 shows how the camera capture and select image, how further process of detection and counting are taken forward to achieve the ultimate goal of performing real-time signal monitoring and according the signals are handled with the help of raspberry board.

Fig 4.2 Input to the Vehicle Detection Module

Fig 4.3 Output to the Vehicle Detection Module

V. Flowchart



VI. YOLO

Object detection starts with few question. What exactly is object detection? Which object needs to be detected. Where is the object placed in the picture? Well this is what the Yolo does. YOLO (You Only Look Once), is a network for object detection. It is the one of the most powerful pretrained model to give utmost accuracy. Yolo is a combined version of R-CNN and SSD, both make Yolo much faster, efficient and powerful algorithm. By applying object detection algorithm in Yolo, one will not only be able to determine *what* is in an image, but also *where* a given object is placed i.e. the location.

Also the model is trained using huge dataset hence it can detect image placed in any random manner i.e. it can detect object even if they are rotated in 360 degree. YOLO is that efficient that it can even distinguish between two very closely placed objects.

Unlike traditional approach of applying classifier on each image and making prediction, Yolo look at the image once and but in a clever way. It divides the image into N numbers of partitions and into MxM grid. Now Yolo applies its algorithm one by one in partitions and predict confidence score, confidence score is the scores that tells us whether object is present or not. On the basis of the confidence score Yolo detects an object.

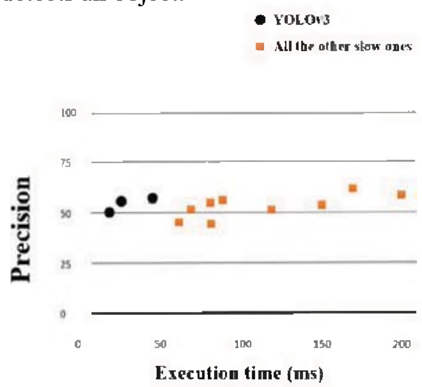


Fig 6.1 Yolo Execution Time Chart

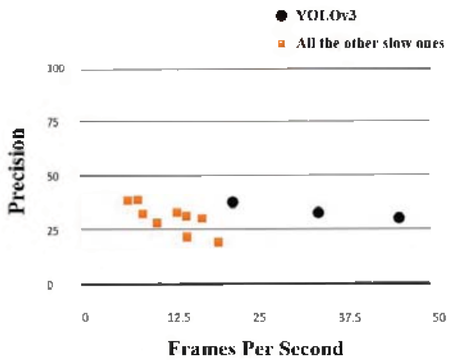


Fig 6.2 Yolo Frames per Second Chart

As shown in the figure 6.1 and 6.2 one can infer that Yolo can process many frames with less execution time as compared to other pretrained models.

Yolo computes its prediction in terms of precision and recall, precision measures how accurate is your predictions and recall measures how good you find all the positives i.e. how correctly the objects are classified. To increase its performance factor Yolo uses IoU, Intersection over Union is an evaluation metric used to measure the accuracy of an object detector on a particular dataset. IoU defines how two closely place objects can be easily detected without hampering the accuracy of the model.

Yolo consist of two core components. One of the Yolo's component R_CNN uses selective search algorithm and proposes accurate bounding box that definitely contains objects whereas the other component SSD that helps is speed processing of an image. Compared to other region proposal classification networks (fast RCNN) which perform detection on various region proposals and thus end up performing prediction multiple times for various regions in an image, Yolo architecture is more like FCNN (fully convolutional neural network) and passes the image (NxN) once through the FCNN and output is (MxM) prediction. This the architecture is splitting the input image in (MxM) grid and for each grid generation 2 bounding boxes and class probabilities for those bounding boxes.

VII. CONCLUSION

Real Time Traffic Signal Monitoring & Handling system's aims to fix the problem of traffic which most of the cities in urban as well as rural areas are facing with the help of this project wherein the focus would be to minimize the vehicular congestion virtually without any installation of any kind of hardware. The setup requires camera and raspberry pi board as its hardware requirement and interfacing thereby forming portable medium. The model trained can be used for efficient traffic flow without creating much chaos on the road. The model may take comparatively more training time but the response time will be less. The model is prepared in such a way that it decide smart switching timing for the signal on all sides of the road so the no one has to wait for longer interval of time on the road and flow of traffic is smooth on the road.

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