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An Intelligent Realtime Traffic Control Based on Vehicle Density

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***Abstract*— These days traffic congestion is becoming a serious problem. Roads and streets are getting over crowded, mainly in large cities leading to long vehicle queue, long hour of traffic on daily basis. This can evoke the day-to-day travellers to violate or break the traffic rules which can sometimes lead to accidents. Controlling and managing traffic system is the most demanding work in present days and the tradition traffic system cannot manage it efficiently. Nowadays worldwide in many big cities Intelligent system is been used for traffic surveillance and controlling. Therefore, we proposed a traffic control and management system which will detect the movement of vehicles, identify, track and count the numbers of vehicles in the lane by analysing a real-time live video feed form the camera with the help of computer vision and after detecting, classifying and counting the numbers of vehicle on a specific lane it will control traffic light according to the set threshold value, threshold value will be based on two criteria one is the density count of the lane and other is priority of that lane. This is done by using OpenCV and (YOLOV3) You Only Look Once real-time object detection algorithm based on CNN (Convolutional Neural Network).**

***Keywords*— YOLOV3, OpenCV, CNN, Camera, Traffic.**

I. INTRODUCTION

As the population is increasing day by day vehicular travel is also increasing rapidly, which is causing a congestion problem. The increased traffic has increased travelling problems like long waiting times, fuel wastages, long vehicle queue and accident mainly in intersection area [1]. Fixed-cycle light controller are not efficient these days they are not solving the long vehicle queue and waiting time problem. Even till this day is many intersections we see policeman managing the traffic instead of traffic light. In today's world where technology has passed all barriers solving most of the human problems has become easy and one of these problems is traffic jam and congestion. An efficient traffic control system is important to reduce the traffic congestion. Which will lead us in the direction to overcome all of these problems. There are some traffic light systems, that uses different sensors to know how crowded the traffic is in real-time [1]. In many countries this system is been implemented but this system can cost more because these sensor needs to be planted literally inside the roads and if something happen to sensor then it will hard to fix but in this paper, we have used computer vision method with advance computer vision technology traffic management and control will be more efficient and low cost as it only requires camera and computer. These days most intersection already have CCTV cameras installed so it just needs proper software to self-monitor and traffic control.

II. EXISTING METHOD USED FOR TRAFFIC CONTROL

A. Manual Control

Manual controlling is simple and basic tactic in which a person is employed at different areas of the lane to control traffic. Traffic controls contains signboard, hand sign, whistle and sign light to control the traffic [4]. In instruction to control the traffic they need to wear traffic police uniform. But traffic police have to face different problems in regulating the traffic all by themselves as the traffic is increasing day by day rule violation, escapes and frauds are done by people.

B. Automatic Control

In this method electrical sensors and timer are used to control traffic light/signals. For every phase a constant value is loaded in the timer and depending on the changes in that timer values, the traffic light gets ON and OFF [4]. The accessibility of signals and vehicles on every phase are captured with the help of the sensors and depending on the signal the lights get switch ON and OFF. This slightly helps to control traffic jams and congestion based on timing attributes.

C. Magnetic Loop Detector

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In MLD method magnetic loop sensors helps to count the density of vehicles on the lane using it's magnetic properties. In this type of traffic management method magnetic detectors are placed inside the road and the radar and infrared sensors which are placed on the side of roads provides limited traffic information [4]. It displays the necessity of distinct schemes for precise management and correct counting of traffic.

D. Inductive Loop Detector

Inductive loop detectors method provides a effective solution for traffic management and controlling but it's only effective in good roads. It's rate of failure is high when they are used in poor highway planes, foremost to fall in pavement life [4]. It obstructs the traffic at the time of repair and preservation.

E. Image Processing

Object detection is related to image processing and computer vision that helps to detect objects of different class in digital videos and images. Human eyes can simply detect traffic jams and congestion by analysing, detecting and processing the real time scenario, image or video the human brain can easily decide whether a jam has happened or not. The images on the road are really a binary data, which needs to be denoted as a digital image which is used as a main input. Computers can only process binary data. The image when captured is raw and unformatted. For the effective processing computer operator need to procedure that raw image and extract useful information from them. Different fields like object recognition, computer vision, image processing etc. have emerged due to need of extracting information from images. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

F. YOLO: Real-Time Object Detection

YOLO is a fast, accurate real-time object detection algorithm [2]. In computer vision object detection is a serious problem where you have to recognize where and what objects are in a given image. The object detection problem is more complicated than object classification, which means object can be recognized but can't be shown where the it is located in the image. In addition, classification doesn't work properly on images which contains more than one object. YOLO algorithm uses totally different process. For doing real- time object detection YOLO algorithm is a clever convolutional neural network (CNN). YOLO (You look only once) applies single neural network to an entire image not like R- CNN which applies thousands of neural network for a single image and then divides the image into regions and predicts probabilities for each region and bounding boxes these bounding boxes are weighted through predicted probabilities and these probabilities depends on the confidence value. YOLO algorithm is popular these days because it's accuracy ratio is high and can be run in real-time. The algorithm named "YOLO" because it requires only one forward propagation pass through the neural network to make predictions.

Previous versions of YOLO algorithm used darknet-19 architecture. Darknet-19 originally having 19 layers but later 11 more layers were added for object detection. The main issue in previous version was inaccuracy in detecting small objects. To resolve this problem, feature maps were concatenated, still there was no significant improvement. The YOLOv3 architecture has 106 convolutional layers due to which its accuracy has been improved and can detect very small objects We have done a detailed comparison among various existing work as described in Table I.

III. PROPOSED WORK

As show in the Fig1, firstly the video will be streaming on all four roads [2]. The values will be read frame by frame and camera will send all the captured input videos to the main center. After the video is received, YOLO algorithm filters the video to count the quantity of the vehicles in every lane. Then based on the set threshold value of every lane, threshold value will be based on two criteria one is the density count of that lane and other is priority of that lane. Every lane will be prioritized and hence the time will be set accordingly. Density will be counted on the basis of the vehicle that will be inside bounding box.

Consider four different lane L1, L2, L3, L4 and every lane will have the equal time T_{max} which denote till what maximum time light of specific lane will be set to green. The signals will turn green lane by lane so lane with less density won't have longer waiting time. If there will be less density or empty lane then no green signal will be turned on for that lane till its density count reaches the threshold. The video of the lanes which have red signal will be recorded and will be sent to main center, first the video will be formatted according to resolution of S x S size [2]. Then YOLO algorithm will perform Object detection on it and density will be calculated and priorities of lanes will be fixed. In this way it will be efficient for automated traffic control using Convolution neural network and computer vision.

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TABLE I

COMPARISON TABLE

Name of author	**P.F. Alcantarila**	**Mohamed B. Trabia, Mohamed S. Kaseko, Murali Ande**	**M. Shahgholian, D.Gharavian**	**J. Vijayaraj , Dr.D.Loganathan**	**Al Hussain Akoum**	**Guohui Zhang**
Title of paper	Automatic Daytime Road Traffic Control and Monitoring System.	A two-stage fuzzy logic controller for traffic signals.	Advanced Traffic Management Systems: An Overview and A Development Strategy	Traffic congestion control of vehicle based on edge detection using image processing.	Automatic Traffic Using Image Processing	A Video-based Vehicle Detection and Classification System for Real-time Traffic Data Collection Using Uncalibrated Video Cameras
Perks	Accurately count the number of vehicles on day time.	Fuzzy logic-based approach isolated intersection.	Increase transportation efficiency improves safety.	Cycle period to the entire region traffic profile.	It uses image processing technique.	Accuracy for the vehicle detection.
Drawbacks	Not work in night-time.	It requires lots of high data and human expertise.	May require a large capital investment.	Performance might get affected by bad weather like fog, rain and snow.	Bad weather like snow, rain, fog might affect performance.	As it is Video based proper installation and keeping lens clean is important.
Infrastructure	B&W camera, Computer vision	Upstream count vehicle detector and presence detector are used.	Point detector, Automatic vehicle identification	Video camera and active monitoring.	Video camera and active monitoring.	Virtual loop detector and Video camera
Method and algorithm	Frame differencing Algorithm and Kalman filtering process.	Average time delay and number. of stopped vehicle in time interval.	Gravity model, Kalman filter, Genetic Algorithm and Naive method is used.	Canny edge detection. Background d subtraction, Image processing method, RGB to Gray conversion for image enhancement.	Filtering method, edge detection technique and object counting method.	Vehicle detection and classification algorithm, Canny edge detection method, length calculation algorithm.
Congestion control	The shadows effect is minimizing Kalman filter and then congestion is control.	Vehicle detectors are used which will be placed at upstream of the intersection	Using traffic information to control traffic nodes.	vehicle density is calculated by subtracting background and foreground image,	Filtering method	Computer-vision based algorithms

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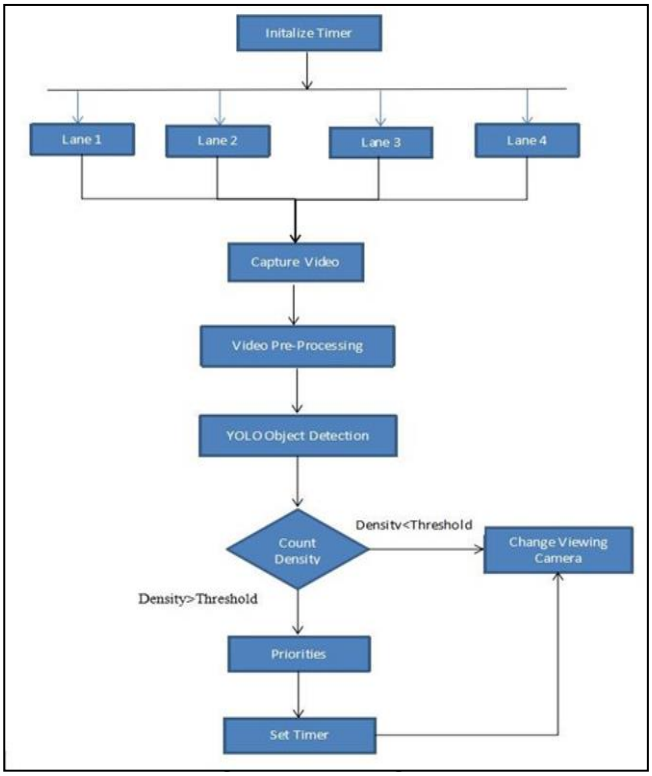

A. Proposed System Architecture

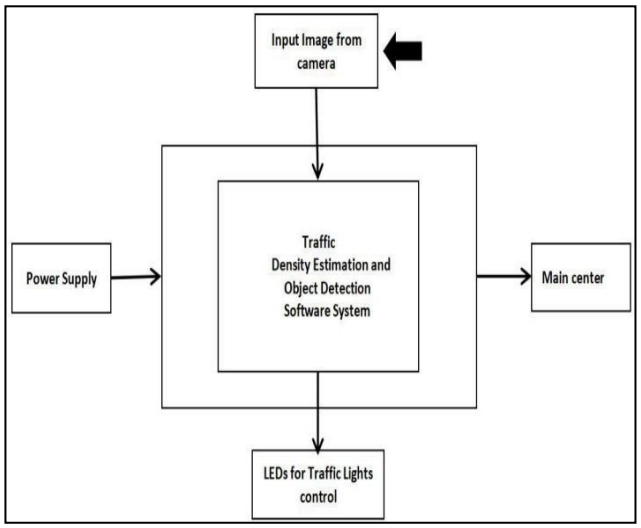

Fig 2: Architecture Design

The Fig 2 shows the working of module. In our system we have manipulated YOLO for only detecting vehicles of different categories .ie Truck, Car, Bus and Motorbike etc.

B. Methodology

In Fig 3, firstly video is capture through the camera than it is divided into frames and these frames are used as input. Then vehicle detection process is done using YOLOv3 to detect the vehicles. Finally, traffic light control is done by counting the total density of vehicles on the lane and setting up a threshold value for each lane, threshold value will be based on two criteria one is density count of that lane and other is priority of that lane.

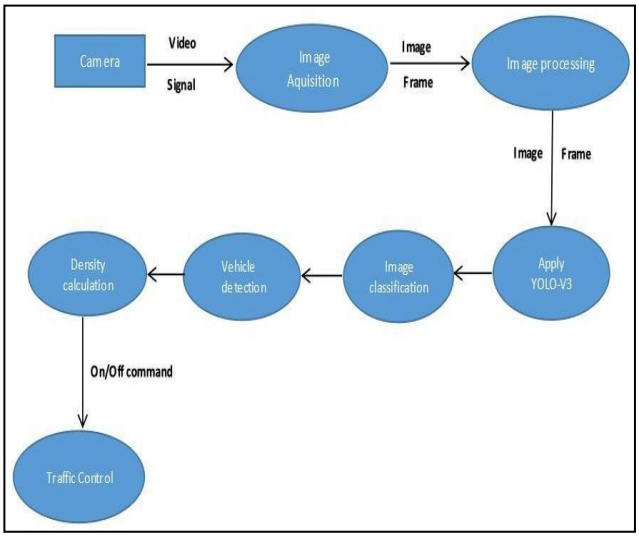

Fig 3: Overview of Methodology

C. Image Capture

CCTV traffic video files are divided into frames and then these frames are used as the input in the image processing, fig3 and fig4 are sample images used for detection process. These are the sample images downloaded from internet. Further, in this paper we will see the detection result which we got after running YOLO algorithm on the sample video.

D. Vehicle Detection

Vehicle detection is a technique which define the vehicle ‘s area in the specified image. Previous detection systems repurpose localizers or classifiers to perform detection. They applied the model at multiple scales and location in an image and the region with high score was considered as detected. Here we use a different technique. We have applied YOLOV3(You look only once) algorithm. YOLO algorithm applies a single neural network to an entire image [7]. Then this network will divide the image into regions and will predicts probabilities and bounding boxes for each region. Bounding boxes are weighted through predicted probabilities as in Fig 4.

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Fig 4: Vehicle image for detection

The bounding box are defined using these descriptions.

Center of bounding box (bx,by). (1)
Width(bw). (2)
Height(bh). (3)
C: Class name of the identified object. (4)

Y= (Pc, bx, by, bh, bw, c)

Pc can be defined as the probability of the object in bounding box.

E. Traffic Light Control

Initially the video will be streaming on all four roads of the traffic circle. The values will be read frame by frame in the streaming video of these roads. Camera sends all the captured input videos to the main center. Once, the video is received, the YOLO algorithm filters the video to count the numbers of vehicles in every lane. Then based on threshold values each lane is prioritized and hence timer is set appropriately to change from green orange and red and red to green. Density is counted on the basis of vehicle category for transport vehicle and containers will have more density as compared to vehicle. Here the density of the vehicles is counted for every lane. The threshold value is based on two criteria one of them is density count of the lane and other is priority of that lane.

Algorithm

Step1: Initialize Program and timer.

Step2: Start feeding video from live traffic camera.

Step3: For each camera frame do read the camera frame.

Step4: Feed these frames to the Object detection YOLO algorithm to create bounding box and confidence value, if (confidence value>=0.4).

Step5: Count vehicle density of each lane.

Step6: if (Count density>threshold).

Step7: Set priorities accordingly.

Step8: Set efficient time slot to change traffic light.

Step9: Change viewing camera.

Step10: elseif (Count density<threshold). Step11: go to step 9.

IV. RESULTS

A. *Videos Result Using YOLOV3*

Sample video was downloaded from internet and was tested and these were the result after testing on YOLO algorithm as in Fig 5. YOLO model has been trained for different sizes of images: 608*608 (High accuracy, less speed) 416*416(moderate accuracy, moderate speed, 320*320(less accuracy, high speed). When the lane contains few numbers of vehicles and camera has proper view angle of vehicles then even (320*320) size can detect the total number of vehicles with good accuracy.

This software was tested on a system with AMD RYZEN 5 processor and 8 GB of RAM. We only need to detect 4 classes and they are “motorcycle”, “car”, “truck”, and “bus” because these are only our interest. The detection was runed at 0.50,0.19,0.35Fps in this system. To run this software smoothly around 15fps 20fps the system must contain heavy specification like i5 or greater processor, TITAN X NVIDIA and NVIDIA GT930 video card.

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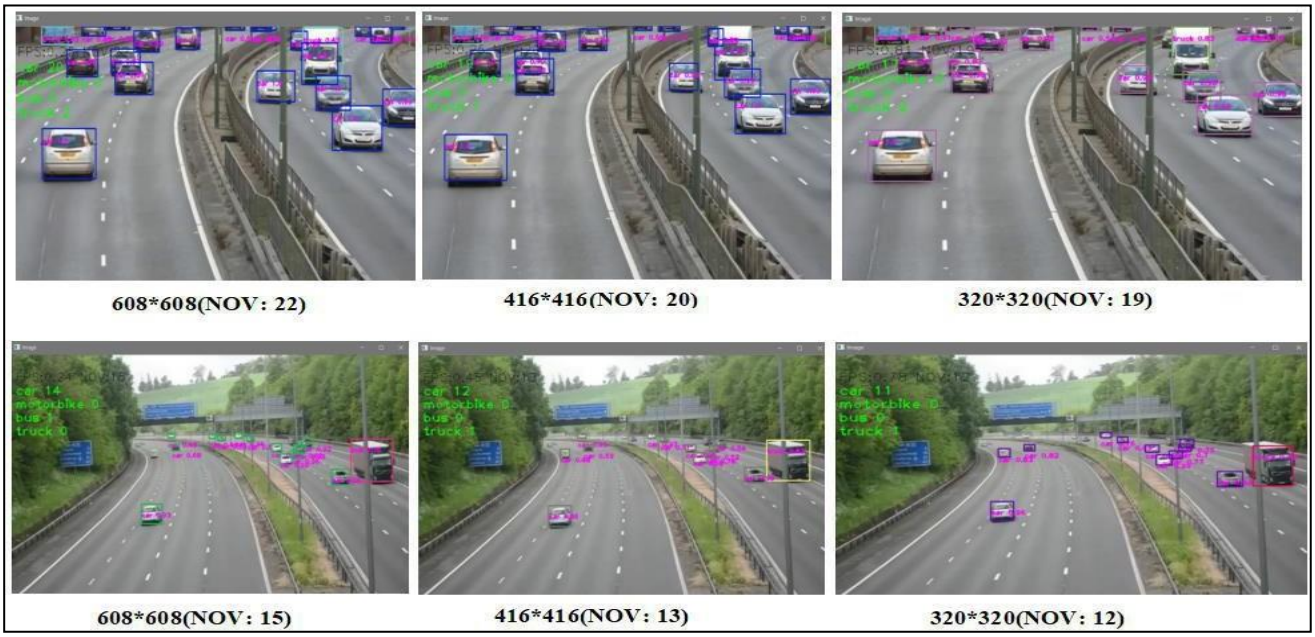

Fig 5: Detection result using YOLOV3

V. CONCLUSION

This paper proposed a smart traffic control and management system which will detect the movement of vehicles, identify, track and count the numbers of vehicles in the lane by analyzing a real-time live video feed form the camera with the help of computer vision and after detecting, classifying and counting the numbers of vehicle on a specific lane it will control traffic light according to the set threshold value, threshold value will be based on two criteria one is the density count of the lane and other is priority of that lane. So that more vehicles can pass safely with less waiting time. We have used pretrained model weights on COCO dataset. YOLO provides very fast inference speed. The major perk of this proposed solution is it's real time detection of the entire scale of vehicles that operate on roads. This proposed solution has shown better results even when there were obstructions and when the density of vehicles was large. The only concern is running the model smoothly as it requires high specification system to run the output on fps>10.

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