A Low Cost Traffic Monitoring and Controlling Mechanism

(A System for Effective Traffic Signal Control based on the Traffic Density)

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***Abstract*— Traffic congestion is a severe problem in many major cities across the world and it has become a nightmare for the commuters in these cities. Conventional traffic light system is based on fixed time concept allotted to each lane of the junction which cannot be varied as per varying traffic density. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. In this paper we are proposing a dynamic traffic management system where the traffic lights are controlled based on the density of vehicles on each lane and if needed allow provision for priority, on dynamic allocation method. This is done by analysing the vehicle density from images captured on continuous basis. The number or the area covered by the vehicles is counted from images and this information is given to the controller to control the timing of the traffic signals.**

This paper suggests a system for controlling the traffic light based on image processing. A camera will be installed alongside the traffic light. It will capture image sequences. The image sequence will then be analysed for vehicle detection. The decision on traffic signal is taken according to traffic conditions on the road traffic light can be controlled based on distinguishing the presence of vehicles (density) in road images. The traffic lights is timed according to the density detected in the corresponding lane. This on implementation will put an end to almost all problems with current traffic management methods. The installation cost for this dynamic traffic management system is less as it can use the already installed cameras in the traffic islands.

Keywords—Digital image processing, dynamic traffic control, OpenCV-Python

I. INTRODUCTION

The number of vehicles on the road is increasing day by day so it is important to manage the traffic flow efficiently in order to utilize the existing road capacity in the best possible way. Traffic congestion is a serious issue nowadays especially in big cities. The main reason behind it is the increase in the population that subsequently increase the vehicular travel, which creates congestion problems. This in turn causes an increase in cost of transportation because of wastage of time and fuel.

Traffic congestion is a state on road networks that occurs due to increased usage. It is characterized by slower speeds, longer travel times, and increased traffic blocks (queuing). When vehicles are fully stopped for periods of time, this is colloquially called a traffic jam. Traffic congestion can cause drivers becoming frustrated and engaging in road rage. In order to avoid the congestion in traffic islands Traffic Signal System (TSS) is used to regulate traffic from different directions and command each lane when to move. An efficient and robust automatic traffic sign detection and recognition can disburden the driver, and thus, significantly increase driving safety and comfort. Generally, traffic signals provide the driver various information for safe and proper navigation. Earlier it was the sole responsibility of the traffic corps to control the traffic, later manual signal controls were introduced where the traffic corps examine the traffic and control the signals. Then came the automatic recognition of traffic signs therefore, became important for smooth and tension free journeys. The present automated traffic control systems that work on time based algorithms. Each lane is allotted a fixed time for the traffic to clear off, the times may be equal for all lanes or based on the average vehicle density.

Later understanding that the traffic density varies with time, it came the need of a system which governs the traffic signals based on the number of vehicles in the lane. Several attempts were made mainly based on sensors, but its inefficiencies made it short lived. Instead of depending on information generated by costly sensors economic situation calls for using available video cameras in an efficient way for effective traffic congestion estimation.

II. PREVIOUS WORKS

The various existing systems for traffic management are studied. Inductive loop detector is an existing method consists of a coil of wire embedded into a groove on the road

surface which is sealed with a rubber [1]. The inductor coil is connected with the detector which detects the change in resonant frequency of the coil loop and accordingly controls the triggering of the relay which is used to trigger the traffic signals [2].

IR based system can be a simple IR LED-Photodiode arrangement which can detect the presence of vehicles. The system works as, when a car passes between the IR transmitter and IR receiver, the IR light is blocked and as the result the resistance of the photodiode increases, this resistance change indicates presence of vehicle [3].

In a method of applying 'Computer Vision for real time smart traffic light' by Ángel Serrano, Cristina Conde, Licesio J. Rodríguez-Aragón [4], the required components from an image taken from road in real time. The processes involved are, 1) Source image taken at the pedestrian crossing, 2) Background image computed with the mode of consecutive frames, 3) subtracted image with no background, 4) convex hull of every component labeled in a grey code and finally 5) filtered image, without spurious components obtained. Then individual components to be tracked through the Kalman filter.

Sachin Grover, Vinay Shankar Saxena, Tarun Vatwani SK [5] explained methods for prototype development after analyzing images from Traffic Control system using image segmentation methods are explained. In cycle Initialization, Image of each lane is capture by calling the image capture module. Then the mode is selected from available normal and intelligent mode. Thus the traffic signal controlled.

Vehicle detection using optical sensors is very challenging as explained by Dr. Swapan Kumar Deb, Rajiv Kumar Nathr in [6] due to huge within class variability's in vehicle appearance. Vehicles may vary in shape, size, and color. The appearance of a vehicle depends on its pose and is affected by nearby objects. Complex outdoor environments, unpredictable interaction between traffic participants, cluttered background are difficult to control. Another key issue is robustness to vehicle's movements and drifts.

From the work by K.Vidhya, A.Bazila Banu, [7], the image captured in the traffic signal is processed and converted into grayscale image then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the image. After calculating the number of vehicles we will came to know in which side the density is high based on which signals will be allotted for a particular side. Raspberry pi is used as a microcontroller which provides the signal timing based on the traffic density.

As explained in A Robust Vision based Moving Target detection and Tracking System by Behrad A, A. Shahrokni, S. A. Motamedi and K. Madani [8], the frames of the traffics obtained from the camera through continuous video processing. To calculate the density, an image from the camera is used to calculate the number of vehicles in each lane. According to the number of vehicles in each lane, the time for respective green signal is given which varies time to time.

V parthasarathil, M.Suryal and B.Akshay in their work ''Smart Control of Traffic Signal System using image processing"[9] explained image acquisition method using a real time live video stream and the algorithm is processed using MATLAB. The ITSC system proposed by Dinesh Rotake, Prof. Swapnili Karmore[10] consist of high-performance, low power AVR_32 microcontroller with 32kbytes of in-system programmable flash memory and in-built 8-channel, 10-bit ADC which is required to process the IR input from sensor network.

III. METHODOLOGY

One goal of this paper is to introduce a system which is cost effective and compatible with the existing system to solve the problems of the present system. Understanding the problems that we face today and the various approaches adopted by different works, we propose a system as shown in Fig. 1.

Block diagram of the proposed system consists of the image capturing device (camera), Image processing part, object detection and the traffic signal controlling algorithm

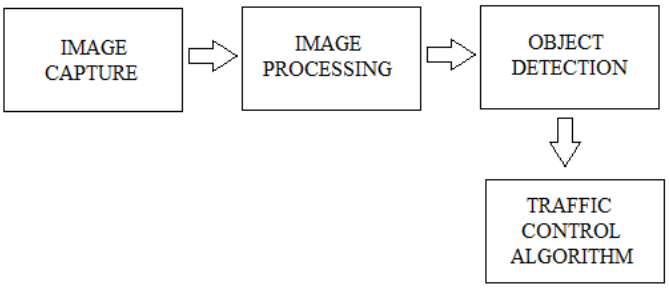

Fig. 1. Block Diagram of the System.

A. *Image Capture*

The sensor which is used to monitor vehicles is an image capturing unit, camera. The frames of images can be effectively analyzed. For this we use the cameras already installed in the traffic islands by the Motor Vehicle Department (MVD) to capture the videos of the traffic.

B. *Image Processing*

In this section, image obtained from camera are processed to get the count of the vehicles. Here we use Raspberry-pi and OpenCV- Python platform to process the video captured. The steps involved are:

- Filtering the image: Here we use a Gaussian filter [11] to filter out the errors such as illumination and intensity variations, poor contrast etc. Filtering helps us to extract the required part of the image by suppressing unwanted variations.
- Conversion of RGB to HSV since the colour information is usually is much noisier than the HSV information, also the effect of shadow is minimized [12].
- Background Subtraction: Here from the subject image the background image (the empty road image) is subtracted. Subtraction operation is taking bitwise XOR of the two images [13]. The resultant image consists only the difference elements of the two images.

- Conversion of HSV image to GRAY: The difference image which is in HSV form is converted to GRAY for thresholding.
- Thresholding: The GRAY image is thresholded to get the binary difference image, which contain only the difference elements.
- Area estimation: Now the region occupied by the vehicles is calculated by the area covered by it. Based on this value approximate time is allotted to each lane.

C. *Object Detection*

The object here i.e. the vehicle is isolated during image processing step is counted based on the area occupied by it in the image. In area estimation we get an area value corresponding to the number of pixels occupied by the vehicle. Based on what percentage of the road is occupied we assign time based algorithm.

D. *Traffic Control Algorithm*

With the area count as the input data we developed an algorithm to control the traffic lights connected to the GPIO pins of the Raspberry pi.

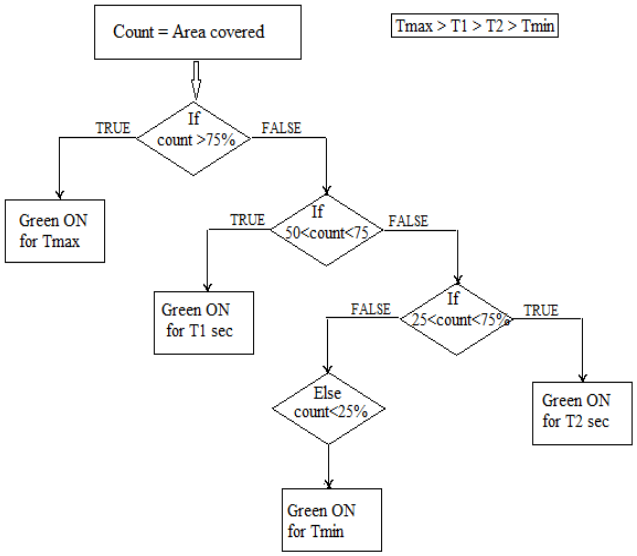

Fig. 2. Flow Chart of the Traffic Control Algorithm

The flow chart shown in Fig. 2 the area covered is taken as 'count' value, and based on it four time delays are assigned. The algorithm is based on what percentage of the total area is occupied by the vehicle. If the traffic is greater than 75% of the total area a maximum time T_{max} is allotted to that lane, similarly if the count is between 50%-75% a lesser time T_1 is allotted, 25%-50% T_2 is allotted and finally if density is less than 25% a minimum value of time i.e. T_{min} is allotted to that lane. The value of T_{max}, T_1, T_2 and T_{min} ($T_{max} > T_1 > T_2 > T_{min}$) depend on the region, vehicular speed, road condition, road type etc.

IV. RESULTS

Based on the above methodology analysis were conducted on different sample images. The programs were done Python 2.7 supported by image processing software OpenCV and its associated libraries. The image is read from the video and is converted to hue saturation and value (HSV) form. The background is subtracted from it to get the subject image i.e. the vehicle. The image is converted to binary and the area of the subject is calculated. The results obtained for a sample as per the above discussed methodology are shown in Fig 3 and Fig. 4. The shell result involves the pixel occupied by the subject (vehicle), and the traffic calculation based on it. Fig. 3 shows a case where there is six cars detected and result indicating 50%-75% traffic. Fig. 4 shows the case with four cars detected indicating 25-50% traffic.

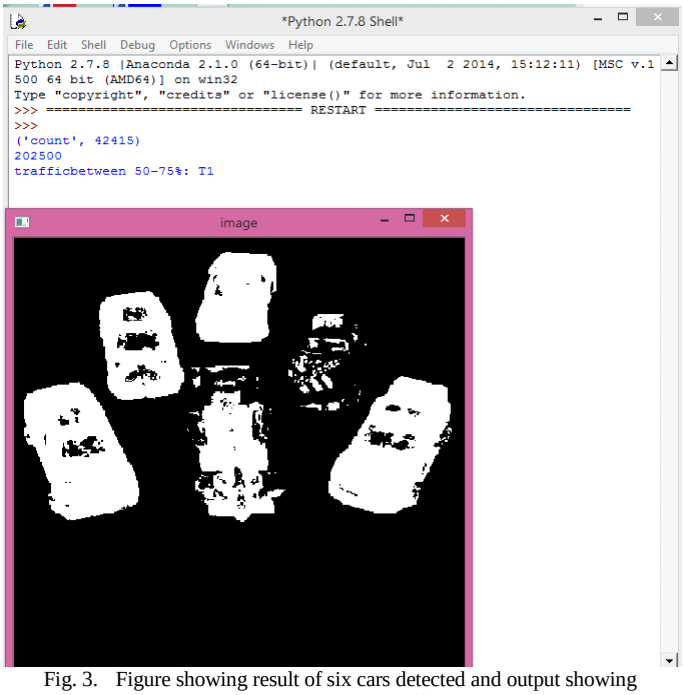

Fig. 3. Figure showing result of six cars detected and output showing 50=75% traffic

Fig. 4.

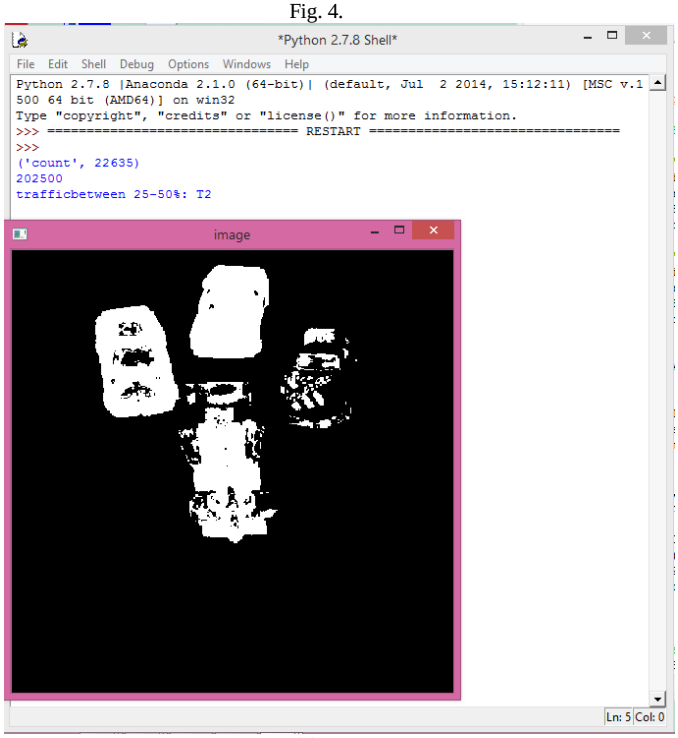

Fig. 5. Figure showing result of four cars detected and output showing 25=50% traffic

V. CONCLUSIONS

The 'A Low Cost Traffic Monitoring and Controlling Mechanism' can resolve the serious issue of Traffic congestion especially in the modern cities. It can put down the increasing cost of transportation because of wastage of time and extra fuel consumption by managing the traffic not on the basis of time but on the basis of the number of vehicles in the lane and time. We conclude that this idea will put an end to almost all problems with current traffic management methods such as time loss for passengers, fuel loss, increased carbon dioxide emission and atmospheric pollution, loss of life due to not reaching the hospital in time, increased cost of travel and transport of products, also increased road accidents due to over speed taken to make up the lost time. The installation cost for this dynamic traffic management system is less as it uses the already installed cameras for over speed detection.

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