A Review of cross road traffic congestion analysis techniques

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***Abstract*—Traffic congestion is a major problem in daily routine. Vehicle density is increasing rapidly due to expansion of facility and technology advancement. Many researchers have applied conventional strategy to resolve the traffic congestion issue, which seems to be still lagging. This scenario has provoked the essential need for modern traffic control system. In respect of such stream, this paper highlights various methods for detection of vehicles density at crossing and their respective control scheme. Individual characteristic of each method is elaborated and compared with each other. The video image processing techniques seems to be the best outcome of this elaborative analysis in place of sensor based system.**

***Keywords*—Traffic congestion, video image processing**

I. INTRODUCTION

Traffic congestion is the most common problem that we face in our daily routine. In today's scenario each person wants to own personal vehicle in order to have better transportation facilities. Hence, Increase in demand leads more production and ultimately more number of vehicles. Traffic congestion causes loss of many important factors like petrol consumption- If traffic caused by any dead lock condition then due to ideal standing condition of vehicles causes unnecessary petrol consumption, ultimately it creates more air pollution. Loss of man hours-people cannot reach on time whether it's about the patient in an ambulance or an employee who works in corporate organization. On seeing current traffic control system which is based on fixed timer based control system. It uses statistical data and provides timing delays to different road lanes depending on priority. Highly dense traffic lane gets more time to clear out and vise-versa. Unfortunately, this data has been taken during peak hours only and traffic lights are working according to that peak hours. So other than peak hours it creates dead lock conditions. To resolve this many research work has been done so far. Some of this methods include RFID tag reader, ultrasonic sensor, namely classified as sensor based traffic control system and a video image processing based methods are also discussed in section II of this paper and overall comparison of all these methods is done in section III and finally section IV includes conclusion which gives final summery of this paper.

II. RELATED WORK

Research work is divided into two parts: detection of vehicles at cross road and from that estimation of traffic density and second part is their controlling algorithm. Classification has been done on the basis of this two parts.

A. Sensor based methods

This class includes on-road mounting of sensors. Primary objective of this sensors is to detect the presence of vehicle and then convey this information to controller. Exchange of information is done through Wireless sensor network (WSN) or via connecting cables. Two basic methods has been discussed here which covers general working principle of other sensor based methods.

1) RFID tag reader

In this method for the detection of vehicle presence RFID tag is used as a sensor [5]. Each vehicle is provided with unique RFID tag which includes information like vehicle model, vehicle type, vehicle number, details of owner and data regarding its routine direction. Near cross road RFID tag reader is to be mounted which reads RFID tags of vehicles crossing nearby. On detecting RFID tag of a particular vehicle, its data base has been generated. It notices direction of vehicle throughout several days likewise it determines direction of each vehicle and gives asymptotic flow of vehicle. After getting direction of traffic flow it regulates traffic lights at crossings.

2) Ultrasonic Sensor

In this method as a sensor ultrasonic transceiver is used [6]. Number of ultrasonic sensors (nodes) are mounted on a road near crossing. Node which is nearer to cross road has less priority and vise-versa. As traffic increases it cuts down the line of sight of nodes. On detecting traffic at last node, which is given highest priority represents it's a highly dense road and it should be treated first.

B. Video Image processing based methods

Video image processing follows sequential procedure for the detection of traffic density. Basic steps are listed as follows:

1. Image acquisition
2. Image pre-processing
3. Noise removal techniques
4. Density calculation
5. Control algorithm

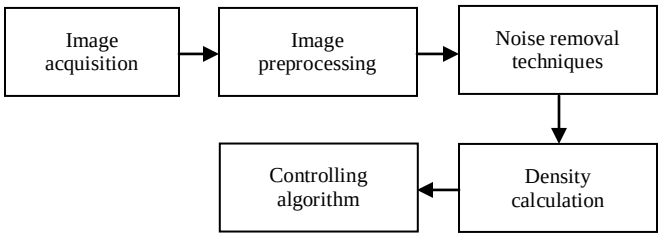

Fig. 1. General block diagram of traffic control system based on image processing techniques.

1. Image acquisition

First stage of vehicle detection is image acquisition. Camera is mounted on a pole with an angle which covers the lane. Real time video is to be taken and from that video, frames are being extracted offline. Extracted frames is then sent to the controller.

2. Image pre-processing

In this section various processing are done on image. Pre-processing includes image cropping, image conversions, contrast adjustments. Image cropping is required to get only useful portion from the image and it reduces computational time. Image conversion is required to convert color image into gray scale or into binary scale depending on which type of operation is required to perform. Conversion of image into other scale is essential because it makes computation fast and also reduces level of noise up to some extent. Image contrast adjustment is required to remove shadow effects from cropped image and to remove additional noise.

3. Noise removal techniques

To remove additional noises various filter operations are performed. To remove salt and pepper noise it requires filter operation. To remove noises from edges, various filter operations like canny filter, Gaussian filter, sobel filter, erosion, corrosion etc.

4. Density calculation

Density calculation is done by calculating total number of edges, by counting total number of pixel values.

5. Control algorithm

Depending on calculated density various control algorithms are generated which gives timing delays according to density.

Image processing based methods vary according to their vehicle detection techniques.One of the method is direct subtraction method [1]. Direct subtraction method requires a reference image, which can be taken from extracted frames. In this case reference image is one which has no vehicles at all. After getting reference image, other images are directly subtracted from it and pixels which are different from reference image can be visible, which directly infers vehicle density. After subtraction accumulation of this pixels is done which is termed as pixel based density calculation.

Another method is calculating vehicle density by calculation total number of edges in image [2]. Human eye is more responsive to edges in image. Edges are significant local changes of intensity. It typically seems on the boundary between two different regions in image. From the edge detection many useful parameters can be extracted like curves, shapes, contour, line, etc. All these features are useful in obtaining basic information about image. Edge detection composed of basic steps namely, smoothing, enhancement, detection and localization. To get more efficient edges from images more advance methods are used. Using derivatives, detection of local maxima or minima of the first derivative or detecting the zero crossing of the second derivative [8].

The Roberts Cross operator performs 2-D spatial gradient measurement which highlights high spatial frequency regionsthat correspond to edges in image. The input to the operator is a grayscale image, as is the output. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point [7].

The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. It is applicable for finding the approximate absolute gradient magnitude at each point in an input grayscale image [7].

The zero crossing detector detects the points where the lapalcian filtered value changes its value sign. It generally happens at points on edges in images where the intensity of the pixels changes rapidly. Zero crossings are obtained on closed contours, and so the output from the zero crossing detector is usually a binary image with single pixel thickness lines showing the positions of the zero crossing points.Initial point for the zero crossing detector is the resulted image of the Laplacian of Gaussian filter. The zero crossings is a function of the size of the Gaussian used for the smoothing. As the smoothing is increased then fewer and fewer zero crossing contours will be found [8].

The Canny operator is known as an optimal edge detector which provides best results than any other edge detecting methods. As an input a gray scale image, and produces as output an image showing the positions of tracked intensity discontinuities.The Canny operator processes in a multi-stage procedure. First stage includes smoothening of the image using Gaussian convolution. Then 2-D first derivative operator similar to the Roberts Cross is applied to the smoothed image which basically highlight regions of the image with high first spatial derivatives. Edges give rise to ridges in the gradient magnitude image. The algorithm then tracks along the top of these ridges and sets to zero all pixels that are not actually on the ridge top so as to give a thin line in the output, a process known as *non-maximal suppression* [7].

III. TABLE OF COMPARISON

TABLE-1
COMPARISON OF DIFFERENT VEHICLE DENSITY DETECTION METHODS

Sr. No.	Methods name	Vehicle density calculation
1.	RFID tag reader method [5]	by counting number of times RFID tag reads vehicles
2.	Ultrasonic Sensor based method [6]	By checking priority sensor and inferring traffic length
3.	Direct subtraction method[1]	By subtracting images from reference image and pixel wise vehicle density calculation
4.	Edge detection method [2]	Counting total number of edges and from that estimation of vehicle density
5.	Gradient magnitude method [3]	Uses canny filter for edge detection and gradient based counting total number of edges
6.	Combined method [4]	Uses both direct subtraction method and edge detection using gradient based filter

IV. ADVANTAGES AND DISADVANTAGES

From table-1 RFID tag reader and ultrasonic sensor based methods are cost effective and they have simplicity in their working principle. If line of sight of these sensor is cut then it indicates presence of vehicle. However, these methods leads to false detection of vehicle presence and also mountings of these sensor near to road lane can cause trouble to incoming vehicles on that particular road. To eliminate false detection of vehicle and mounting problems image processing techniques are quite preferable. Direct subtraction method works efficiently but it requires reference image more accurate, also reference image should vary with respect to time for better performance in detecting vehicle presence. Edge detection method are more preferable over other image processing techniques as it gives accurate edge detection whenever any change in intensity level occurs.

V. CONCLUSION

On reviewing all these methods gradient based vehicle density calculation is preferable as it uses canny filter for edge detection and also uses direct subtraction method for better accuracy.

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