STUDY OF TECHNIQUES FOR INTELLIGENT TRAFFIC CONTROL SYSTEM

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ABSTRACT

Increase inpopulation is a known fact which is leading to increase in traffic. The problem of traffic congestion is becoming serious day after day. The need of the hour is to have an automated or intelligent traffic light system, which can resolve the problem of traffic congestion. In order to resolve this problem, an efficient system is required to judge the present scenario at each traffic light to handle and distribute the traffic in a fast manner. Up till now a lot of research work has been done and many new methods have been evolved in order to make traffic lights intelligent.

This paper contains a literature review of the various methods applied till the present day inorder to make traffic lights intelligent. Also certain issues faced by the researchers have been discussed.

Keywords: Traffic, Image Processing, Edge Detection, Image Cropping.

I INTRODUCTION

Mass event with large attendance hold in big cities, overload road infrastructure at regular intervals [1][3]. Hence for better utilization of road infrastructure it is important to manage traffic flow efficiently[4]. Most of the city traffic is controlled by sensors and cameras which shall be installed in big highways and street. A result of traffic congestion is increasing transportation cost as congestion leads to waste of fuel and time [2][5]. Traffic jams are also result of congestion and flaws or loop holes in traffic management system.Traffic load is highly dependent on time, day, season, weather. Hence it becomes difficult to be controlled on the prior recorded data sets. Therefore real time handing is required. A traffic control system with its own intelligence can solve these problems by continuously sensing and adjusting the timing of traffic lights according to the actual traffic load. The advantages of building traffic control system functioning on its own intelligencereduces congestion, reduction in operational cost, increase in capacity of road infrastructure, traffic can be regulated as per its density[6].For more efficient management of traffic there is a need for identification and preference being given to heavy duty trucks as compared to LMVs. Unfortunately this system has not been implemented on any of the traffic lights.

II EXISTING TRAFFIC CONTROL SYSTEM

From the past decades, management of traffic has been one of the biggest issues of modernization. Researchers have followed a long way to overcome the traffic crises. Right from the very beginning of, "Manual Traffic Control" in which man power was required to control the traffic. Depending on countries and states the traffic polices are allotted to different areas to control traffic. These men carry sign board, sign light and whistle to control the traffic. They are instructed to wear specific uniforms in order to be easily identified by the drivers[2].

After this came the traditional "Vehicle Actuated Control System" in which, lights are loaded with constant numerical value in the form of timers. The lights are automatically getting ON and OFF depending on timer value changes. The main disadvantage is that the algorithm for this control system does not change the green signal even if the traffic has already passed until the counter is complete, while not taking into account the number of vehicles waiting at red. Hence the density of the traffic does not matter[6].

Next in generation is the "Automatic Traffic Light", which is the modified version of vehicle actuated control system with addition to timers and electrical sensors.In this technique electronic and electrical sensors are added to detect vehicles and produce signals that the time is being wasted by a green light on an empty road.

Drawbacks to these particular controlling methods:-

1. Only skilled operators can make suitable judgement and decisions because sometimes the situation is very complicated and many factors are needed to be considered.
2. The operator is under very high work load as he has to continuously take decisions and review the traffic conditions at small intervals of time.
3. Using electronic sensors to detect vehicles and produce signal takes time which wastes a lot of green light on the empty road [6][2].

The established traffic control management systems are inadequate for handling huge amount of traffic load as they are incapable of meeting the growing number of vehicles on road.

III IMAGE PROCESSING: A SOLUTION

With a perfect structural system built around computers and cameras continuously monitoring the traffic on particular roads will solve all the drawbacks in the present controlling system for traffic. This structure includes:

1. A hardware model.
2. A software model[7][8].

Image processing systems are becoming widely popular due to easy availability of powerful personnel computers, large memory devices, graphic software and many more. These technologies are used for enhancing images taken from the cameras set at traffic lights.Using these techniques and the structure built a flexible traffic light controller can be created which shall take traffic density, moving time and type of vehicles on the signal into account[6].

This type of system detects vehicles through images instead of using electronic sensors embedded in a pavement. The camera installed alongside the traffic light captures images. The images are then analysed using digital image

processing for vehicle detection according to which the road traffic light can be controlled[9].

Using image processing there are several methods which can be used in order to make traffic lights intelligent. They are viz. edge detection, image cropping, background subtraction, object tracking, speed calculation.

The basic steps involved in using digital image processingfor solving these problems are:

1. **Image Acquisition:** It is done with the help of camera installed at the traffic light which is a two dimensional function f(x,y), where x and y are plane coordinates. The amplitude of the image at any point is called its intensity. We need to convert these x and y values to finite discrete values to form a digital image. We need to convert the analog image into a digital image to process it through digital computer.
2. **RGB to Gray conversion:** Images of the road are captured. RGB to Gray conversion is done on the progression of captured images[9]. The reason behind why coloured images are often stored in gray scale is, in RGB format there are three separate image matrices storing amount of red, amount of green, amount of blue in each pixel, whereas in gray scale we do not differentiate how much we emit of different colours, we emit the same amount in every channel. This particular function of conversion can be easily done using MATLAB.

Fig. 1: RGB to Gray conversion [2]

3. **Image Enhancement:** The acquired image in RGB is first converted into Gray. Now we want to bring our image in contrast to background so that the appropriate threshold level may be selected while binary conversion is carried out. This calls for image enhancement techniques. The objective of enhancement is to process an image so that result is more suitable than the original image for the specific application[9]. Image enhancement alters the visual impact that the image has on the interpreter in a fashion that improves the information content.
    a. Contrast enhancement
    b. Intensity, Hue, and Saturation transformations
    c. Intensity slicing
    d. Edge enhancement
    e. Making digital mosaics
    f. Reducing synthetic stereo images [15].

After following these steps, various methods are used as per once convenience and goals for control of traffic.

1. **Edge detection:** The methods for edge detection locate the pixels in the image that correspond to the edges of general algorithms used as Sobel, Prewitt, Roberts, Log, Zero-cross, Canny. These edge finding methods have been incorporated into MATLAB as predefined functions[9]. Edge detection can be divided into five cases as per quantitative evaluation of performance.

a. Good Detection: There should be minimum number of false edges. Threshold should be high enough leading to less false edges.

b. Noise sensitivity: Certain acceptable noise environment does not affect the detected edges.

c. Orientation Sensitivity: The operator not only detects the edge magnitude but also its orientation.

d. Good Localization: The edge location must be reported as closed as possible to the location.

e. Speed and Efficiency: The algorithm should be fast enough to be useable in an image processing system. An algorithm that allows recursive implementation or separately processing can greatly improve efficiency[6].

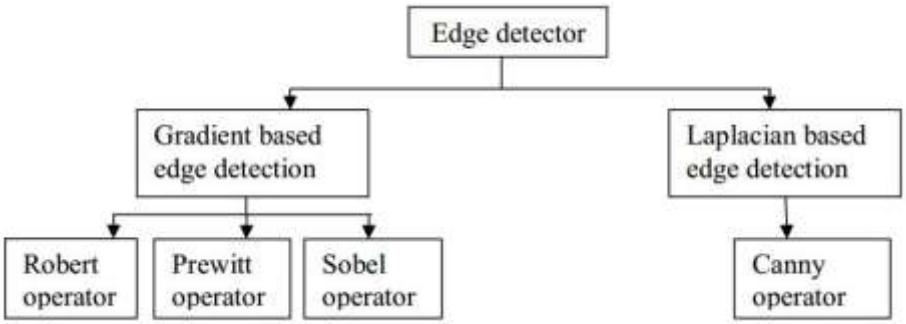

Fig.2: Different edge detection technique [6]

Fig. 3: Edge detected Picture from MATLAB

2. **Image Cropping:** This step is done to select the targeted area using image cropping algorithms in MATLAB. Using this we can separate the region of the road where vehicles are present. Hence forth all background information is excluded. For image cropping we have to use a reference image of the same area which is to be cropped. Binary image of the same dimension is created with only the required area shaded white and then

multiplication of the reference image with the white image results in the final desired target area[4].

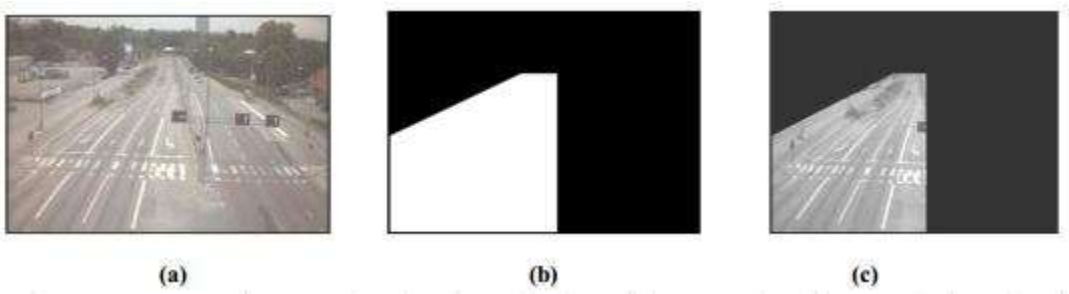

Fig.4: (a) Reference Image taken from the Live Video from [10],
(b) Defining the region of interest, (c) Selection of the target area [4]

3. **Background Subtraction:**Subtract cropped image of scene from the Region of interest to get the area occupied by the vehicle. This can be achieved by applying ANDing operation to the image and the region of interest. The logic is structured generated by asphalt image in Region of Interest and the change structure due to occupied vehicle[9]. This technique on a large scale is efficient in calculating the density of traffic on a road and this density is further used for comparison between different roads on a crossroad.

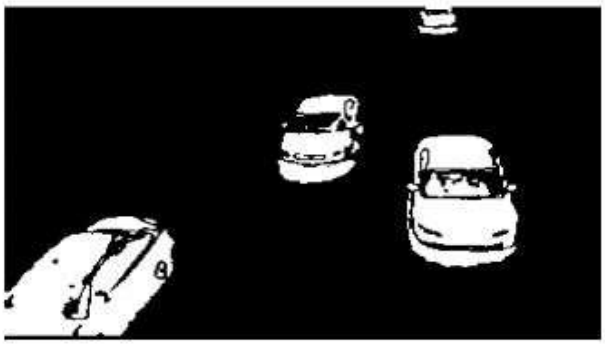

Fig.5: Background subtraction [9]

4. **Object tracking:** objects are detected frame by frame in a video. It is a crucial part of smart surveillance systems since without object tracking the system could not extract cohesive temporal information about objects[11].

Vehicle tracking can be done using the method named as contour extraction. This type of extraction consists of steps including gamma correction and background masking. The masking algorithm is as follows: $N(P) = M(P) \times V(P)$

This type of masking must be applied to each RGB image separately[7].

5. **Speed Calculation:** After tracking each object in a video we can save the frame number that the object entered

the scene(f_o) and also the frame object left the scene. Speed calculation can be held out by calculating the number of frames consumed by object to pass by the scene, since we know that the duration of each frame, we can calculate the total time taken by object to pass by the whole scene. Hence forth giving the vehicles speed[11][12].

IV RELATED RESEARCH

The theme is to control the traffic by determining the traffic density on each side of the road and control the traffic signal intelligently by using the density information. The paper[4] presents the algorithm to determine the number of vehicles on the road. The density counting algorithm works by comparing the real time frame of live video by reference image and by searching vehicle in the Region of Interest. In this technique in order to deal with noises added due to different lightening conditions at different times of the day, a set of reference images have been stored at different time slots of the day. The system cycles through these reference images according to the current time of the day.

As per SabyasanchiKanojia, image processing techniques and wireless communication networks can avoid traffic congestion for day time sequences efficiently. This particular method uses ZIGBEE protocol to wirelessly transmit the information of the road scene. This information will be displayed nearby the roads which can help people by providing pre knowledge of traffic jams and congestions. Thus this traffic jam congestion detection method is based on various techniques: change detection, image processing and incorporation of prior information such as traffic model and road network. This method, after analysing the density of traffic, manipulates the timer for green light as per the density on each road[5].

Another technique for traffic management at crossroad was given in the paper[2] which uses surveillance cameras and electronic sensorsin order to find out the number of vehicles. The basic technique is background subtraction. Here an image of the road without any traffic is stored in the processor and then its comparison is done with the real time image. The less the image is matched the more is the traffic on the road. Hence the green light is ON for a longer period of time. Edge detection technique is used for image matching. Canny edge detector is used as this is the most efficient one and can further be used for contour tracing. After detecting the edges and subtracting the background, number of vehicles on the road can be calculated.

In [16] the drawbacks of infrared and radio frequency were resolved as the basic requirement of these systems is, a transmitter circuit has to be installed at every traffic signal. The algorithm was inspired by YUN-CHANG[13] who used artificial intelligence(AI) for traffic control using fuzzy mapping. In [1] colour detection and coordinate analysis of the detected colour has been used. The colour detection for various UGVs was used which generated a stop signal at the traffic light whenever traffic on the other road was found more dense. This algorithm had the most optimum execution time.

Another algorithm for intelligent traffic control unit was given in [9]. Here Pallavi gave a technique for the use of traffic density for controlling the lights by edge detection. Here binary images with pixels detected are used by common operators Sobel and Laplace. After edge detection the matching is done on the bases of edges in the image

with the reference image stored in the processor. Depending upon the percentage of matching the timer for green and red light is controlled.

A very different system was built by Ryan and Guohui Zhang, where object tracking was done on the bases of vehicle length in a video frame. They followed Video based Vehicle Detection and Classification (VVDC). They made the algorithm/technique which corrected the 97% truck count error and brought it down to 9%. Hence this made the traffic control system efficient by taking the size of vehicle in to account. The bigger vehicles were found on the road, the greater time was allotted to them for crossing the traffic light [14].

V INFERENCES DRAWN AND DISCUSSIONS

Considering all the literature studies above, it has become clear that traffic is proportionally increasing with the increase in population. Traffic congestion being the most difficult problem to be dealt with. There have been several studies and new techniques have been evolved for tackling this problem. All these methods follow the same methodology to some extent. The methodologies are as follows:

- Image Acquisition
- Image Preprocessing
- Image Cropping/background subtraction
- Edge Detection
- Calculation of Density

The overall efficiency and effectiveness of the technique depends upon the methodology being followed. Image cropping/background subtraction is a very crucial stage and hence many techniques have been found to obtain a proper subtracted image. This is because the preciseness of the extracted feature will majorly depend on the quality of the cropped image.

Several techniques like edge detection, counting of edges, vehicle tracking, object identification, speed calculation and colour detection are being implemented for an optimum use of traffic lights. These algorithms do take care of the time and fuel being wasted at the traffic signal. Hence by the use of these techniques traffic lights are being made intelligent, as they operate taking the traffic scenario at that particular time. Artificial intelligence and fuzzy mapping with the help of data sets is used for taking the record of traffic density at different times, weather and particular days of the year.

From all the literature studies, it was observed that all the authors emphasize on designing a system that can be employed for intelligent traffic surveillance system, and at the same time follow the methodology to obtain a robust system. Accuracy and precision is still a problem and more research need to be done in this field.

VI CONCLUSION

From the complete literature survey, it can be concluded that no matter whatever methodology is being employed by the author, the main focus is to use a precise and correct segmentation technique. Many techniques have been developed to make traffic light intelligent. Image processing has done a major contribution in this field by making

the traffic lights take decisions on a real time basis.

Even after so many techniques,problems are still faced when it comes to congestion and problems in image acquisition. Many times there are certain noises which can distort the images, leading to wrong decision by the traffic light. Researchers are still looking for technique which can help to develop a robust, fully automated traffic control system which can be efficiently used for controlling congestion and traffic jams on the road infrastructure.

REFERENCES

[1]. "Traffic Light Solution for U.G.V. Using Digital Image Processing"- NiranjanBhattacharayya, Akshay Kumar Singh, SiddhantKapil, Harshul Jain, Abhishek Jain, International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231 -2307, Volume-4, March 2014.

[2]. "Traffic Control Using Digital Image Processing"- Chandrasekhar. M, Saikrishna. C, Chakradhar. B, Phaneendra Kumar. P &Sasanka. C ,IJAEEE, Volume-2, Issue-5, 2013.

[3]. "REAL-TIME IMAGE PROCESSING FOR ROAD TRAFFIC DATA EXTRACTION FROM AERIAL IMAGES"- D. Rosenbaum, J. Leitloff, F. Kurz, O. Meynberg, and T. Reize, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7B.

[4]. "Real Time Traffic Density Count using Image Processing"- Naeem Abbas, Muhammad Tayyab, M.TahirQadri, International Journal of Computer Applications (0975 – 8887) Volume 83 – No 9, December 2013.

[5]. "Real –time Traffic light control and Congestion avoidance system"- Sabyasanchikanojia, IJERA, Vol. 2, Issue 2,Mar-Apr 2012, pp.925-929.

[6]. "Traffic Light Control System Using ImageProcessing"- Kavya P Walad, Jyothi Shetty, IJIRCCE, Vol.2, Special Issue 5, October 2014.

[7]. "Automatic Traffic Estimation Using Image Processing"- PejmanNiksaz, International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 5, No. 4, December, 2012.

[8]. R. Danescu, S. Nedevschi, M. Meinecke and T. Graf, "Stereo Vision Based Vehicle Tracking in UrbanTraffic Environments", Intelligent Transportation System, IEEE conference on, (2007), pp. 400-404.

[9]. "Real Time Traffic Light Control System Using Image Processing"- S.Aishwarya, P.Manikandan, IOSR Journal of Electronics and Communication Engineering(IOSR-JECE), PP 01-05.

[10]. Live Video of CCTV Camera for Traffic Monitoring in Stockholm, available at http://www.trafiken.nu/sv/Stockholm/trafiklaget/Kamero r/Roslagsvagen/Albano/

[11]. "Speed Detection Camera System using Image Processing Techniques on Video Streams"- Osman Ibrahim, HazemElGendy, and Ahmed M. ElShafee, Member, IEEE, International Journal ofComputer and Electrical Engineering, Vol. 3, No. 6, December 2011.

[12]. Image Processing Edge Detection Technique used for Traffic Control Problem"- P.Srinivas ,Y.L. Malathilatha,Dr. M.V.N.K Prasad, International Journal of Computer Science and Information

Technologies, Vol. 4 (1) , 2013, 17 – 20.

[13]. Yun-Chung Chung et al, "A Vision-based Traffic Light Detection System at Intersections", Journal of Taiwan Normal University: Mathematics, Science & Technology 47(1), 67-86, 2002.

[14]. "A Video-based Vehicle Detection and ClassificationSystem for Real-time Traffic Data Collection UsingUncalibrated Video Cameras"- Guohui Zhang, Ryan P. Avery, TRB 2007 Annual Meeting.

[15]. Bernstein, R.M., K. Edwards and E.M. Eliason, 1975, 'Synthetic Stereo and Landsat Pictures', Photogrammetric Engineering, Vol. 42, pp.1279-1284