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# SMART TRAFFIC DETECTION SYSTEM USING CANNY EDGE DETECTION

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**ABSTRACT**

The current methods used such as timers or human control are proved to be inferior to alleviate this crisis. In this project, a system to control the traffic by measuring the real-time vehicle density using canny edge detection with digital image processing is proposed. This imposing traffic control system offers significant improvement in response time, vehicle management, automation, reliability and overall efficiency over the existing systems. As the problem of urban traffic congestion intensifies, there is a pressing need for the introduction of advanced technology and equipment to improve the state-of-the-art of traffic control. Besides that, the complete technique from image acquisition to edge detection and finally green signal allotment using four sample images of different traffic conditions is illustrated with proper schematics and the final results are verified by hardware implementation.

## I INTRODUCTION

As the population of the modern cities is increasing day by day, vehicular travel is increasing which is leading to congestion problem. Traffic congestion has been causing many critical problems and challenges in the major and most populated cities. Due to this traffic congestion there is more wastage of time. The steady increase in the number of automobiles on the road has amplified the importance of managing traffic flow efficiently to optimize utilization of existing road capacity. High fuel cost and environmental concerns also provide important incentives for minimizing traffic delays.

The system is intended to overcome the drawbacks, which are there in the existing systems implemented until now for the traffic management system. This system uses cameras installed at intersections to monitor traffic dynamically. It then processes the extracted information using an algorithm called Canny Edge

Detection, computes the volume of traffic and sets the timer of the signal accordingly. Canny Edge Detection is the best algorithm to detect the vehicles because it uses multi-stage algorithm to detect the captured images. It also monitors the scope of congestion at the intersection and adjusts the timer to prevent it.

The entire system works autonomously and has a quick turnaround time, saving critical resources at every junction. Traffic congestion is a serious issue. In the existing system, signal times are fixed and it does not depend on the density of traffic. Large red light delays lead to traffic congestion. In this paper, a traffic control system is implemented in which signal timings are updated based on the traffic density. The system is using Open CV and Arduino. Image processing of traffic video is done in Open CV. The system uses Canny Edge Detection technique to compute the traffic density.

Traffic congestion is one of the major modern-day crises in every big city in the world. Recent study of World Bank has shown that average vehicle speed has been reduced from 21 km to 7 km per hour in the last 10 years in Dhaka [1]. Inter metropolitan area studies suggest that traffic congestion reduces regional competitiveness and redistributes economic activity by slowing growth in county gross output or slowing metropolitan area employment growth [2].As more and more vehicles are commissioning in an already congested traffic system, there is an urgent need for a whole new traffic control system using advanced technologies to utilize the already existent infrastructures to its full extent. Since building new roads, flyovers, elevated expressway etc. needs extensive planning, huge capital and lots of time; focus should be directed upon availing existing infrastructures more efficiently and diligently.

Previously different techniques had been proposed, such as infra-red light sensor, induction loop etc. to acquire traffic date which had their fair share of demerits. In recent years, image processing has shown promising outcomes in acquiring real time traffic information using CCTV footage installed along the traffic light. Different approaches have been proposed to glean traffic data. Some of them count total number of pixels [3], some of the work calculate number of vehicles [4- 6].These methods have shown promising results in collecting traffic data.

However, calculating the number of vehicles may give false results if the intra vehicular spacing is very small (two vehicles close to each other may be counted as one) and it may not count rickshaw or auto-rickshaw as vehicles which are the quotidian means of traffic especially in South-Asian countries. And counting number of pixels has disadvantage of counting insubstantial materials as vehicles such as footpath or pedestrians. Some of the work has proposed to allocate time based solely on the density of traffic. But this may be disadvantageous for those who are in lanes that have less frequency of traffic.

Edge detection technique is imperative to extract the required traffic information from the CCTV footage. It can be used to isolate the required information from rest of the image. There are several edge detection techniques available. They have distinct characteristics in terms of noise reduction, detection sensitivity, accuracy etc. Among them, Prewitt [7], canny [8], Sobel [9], Roberts and LOG are most accredited operators. It has been observed that the Canny edge detector depicts higher accuracy in detection of object with higher entropy, PSNR(Peak Signal to Noise Ratio), MSE(Mean Square Error) and execution time compared with Sobel, Roberts, Prewitt, Zero crossing and LOG [10-12].Here is a comparison between distinct edge detection techniques [13].

## MANUAL CONTROLLING

Manual controlling the name instance it require man power to control the traffic. Depending on the countries and states the traffic polices are allotted for a required area or city to control traffic [2]. The traffic polices will carry sign board, sign light and whistle to control the traffic. They will be instructed to wear specific uniforms in order to control the traffic.

## AUTOMATIC CONTROLLING

Automatic traffic light is controlled by timers and electrical sensors. In traffic light each phase a constant numerical value loaded in the timer. The lights are automatically getting ON and OFF depending on the timer value changes. While using electrical sensors it will capture the availability of the vehicle and signals on each phase, depending on the signal the lights automatically switch ON and OFF.

## IMAGE PROCESSING IN TRAFFIC LIGHT CONTROL

We propose a system for controlling the traffic light by image processing. The vehicles are detected by the system through images instead of using electronic sensors embedded in the pavement. A camera will be placed alongside the traffic light. It will capture image sequences. Image processing is a better technique to control the state change of the traffic light. It shows that it can decrease the traffic congestion and avoids the time being wasted by a green light on an empty road. It is also more reliable in estimating vehicle presence because it uses actual traffic images. It visualizes the practicality, so it functions much better than those systems that rely on the detection of the vehicles' metal content.

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This system uses cameras installed at intersections to monitor traffic dynamically. It then processes the extracted information using an algorithm called Canny Edge Detection, computes the volume of traffic and sets the timer of the signal accordingly. Canny Edge Detection is the best algorithm to detect the vehicles because it uses multi-stage algorithm to detect the captured images. It also monitors the scope of congestion at the intersection and adjusts the timer to prevent it. The entire system works autonomously and has a quick turnaround time, saving critical resources at every junction.

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## II LITERATURE SURVEY

### LITERATURE SURVEY ON IMAGE PROCESSING AND ITS APPLICATIONS

A few researches such as application to satellite images, wire-photo standards conversion, medical imaging, videophone, character recognition, and photograph enhancement were also carried out [1].

Suezou Nakadateet al [2] discussed the use of digital image processing techniques for electronic speckle pattern interferometer. A digital TV-image processing system with a large frame memory allows them to perform precise and flexible operations such as subtraction, summation, and level slicing. Digital image processing techniques made it easy compared with analog techniques to generate high contrast fringes.

Satoshi Kawataet al [3] discussed the characteristics of the iterative image- restoration method modified by the reblurring procedure through an analysis in frequency space. An iterative method for solving simultaneous linear equations for image restoration has an inherent problem of convergence. The introduction of the procedure called “reblur” solved this convergence problem. This reblurring procedure also served to suppress noise amplification.

William H [4] highlighted the progress in the image processing and analysis of digital images during the past ten years. The topics included digitization and coding, filtering, enhancement, and restoration, reconstruction from projections, hardware and software, feature detection, matching, segmentation, texture and shape analysis, and pattern recognition and scene analysis.

David W. Robinson [5] presented the application of a general-purpose image- processing computer system to automatic fringe analysis. Three areas of application were examined where the use of a system based on a random access frame store has enabled a processing algorithm to be developed to suit a specific problem. Furthermore, it enabled automatic analysis to be performed with complex and noisy data.

S V Ahmed [6] discussed the work prepared by concentrating upon the simulation and image processing aspects in the transmission of data over the subscriber lines for the development of an image processing system for eye statistics from eye.

P K Sahooet al [7] presented a survey of thresholding techniques and updated the earlier survey work. An attempt was made to evaluate the performance of some automatic global thresholding methods using the criterion functions such as uniformity and shape measures. The evaluation was based on some real world images. Marc Antoinette al [8] proposed a new scheme for image compression taking psycho visual features in to account both in the space and frequency domains. This new method involved two steps. First, a wavelet transforms in order to obtain a set of bi orthogonal subclasses of images; the original image is decomposed at different scales using pyramidal algorithm architecture. Second, according to Shannon's rate distortion theory, the wavelet coefficients are vector quantized using a multi resolution codebook.

## VEHICLE DETECTION AND COUNTING

Automatic detecting and counting vehicles in unsupervised video on highways is a very challenging problem in computer vision with important practical applications such as to monitor activities at traffic intersections for detecting congestions, and then predict the traffic /of which assists in regulating traffic. Manually reviewing the large amount of data they generate is often impractical.

Guohui Zhang et.al., [1] proposed a Video-based Vehicle Detection and Classification (VVDC) system for collecting vehicle count and classification data. The proposed approach can detect and classify vehicles using un calibrated video images. The ability to use un calibrated surveillance cameras for real-time traffic data collection enhances the usefulness of this prototype VVDC system.

H.S. Mohana [2] et.al., developed a new approach in detecting and counting vehicles in day environment by using real time traffic flux through differential techniques. Counting object pixel and background pixel in a frame leads to the traffic flux estimation.

Laura Munoz et.al., [3] proposed a system to estimate traffic density with the cell transmission model. This uses cell densities as state variables instead of cell occupancies, and also accepts non uniform cell lengths, and allows congested condition to be maintained at the downstream boundary of a modeled freeway section. Using cell densities instead of cell occupancies permits to include uneven cell lengths, which leads to greater flexibility in partitioning the highway.

Tomas Rodriguez et.al., [4] proposed a system on real time traffic monitoring; the system is self-adaptive and is able to operate autonomously for long periods of time, i.e. no hidden parameters to be adjusted. It performs in all weather condition and automatically selects the appropriate algorithm for day, night and transition periods.

P.F Alcantarilla et.al., [5] proposed a automatic road traffic control and monitoring system for day time sequence using a black and white camera. Important road traffic information such as mean speed, dimension and vehicles counting are obtained using computer vision methods. Firstly, moving objects are extracted from the scene by means of a frame-differencing algorithm and texture information based on grey scale intensity. However, shadows of moving objects belong also to the foreground. Shadows are removed from the foreground objects using top hat transformations and morphological operators. Finally, objects are tracked in a Kalman filtering process, and parameters such as position, dimensions, distance and speed of moving objects are measured.

Frank Y. Shih et.al., [6] proposed a system for automatic seeded region growing algorithm for color image segmentation. First, the input RGB color image is transformed into YCbCr color space. Second, the initial seeds are automatically selected. Third, the color image is segmented into regions where each region corresponds to a seed. Finally, region-merging is used to merge similar or small regions.

M. Vargas et.al.,[7] proposed a system for video based traffic density estimation. Successful video-based systems for urban traffic monitoring must be adaptive to different conditions. They should include algorithms for detection of moving vehicles and shortterm stood-still vehicles (especially important in urban environments).

Yi-Hsien Chiang et.al., [8] proposed a system which devises a freeway controller that is capable of stabilizing traffic flow when the traffic system is in the unstable (congested) phase, in which a shock wave is likely to occur in the presence of any in homogeneity and where the system is on the verge of a jam condition.

Yeh et.al., [1] have applied fuzzy multi-criteria analysis to performance evaluation for urban public transport system. The fuzzy multi-criteria analysis provides crisp ranking outcomes for the evaluation problem. An empirical study of 10 bus companies in Taipei's public transport system has been carried out to exemplify the approach.

Wen et.al., [2] have developed probabilistic neural network to solve incident detection problem. Efficient incident management is an important issue in freeway traffic management system. A wide range of incidents that include different patterns under a variety of flow conditions and traffic periods were generated to train and evaluate the performance and the transferability of the proposed probabilistic neural network-based algorithm.

Sadek et.al., [4] have examined the potential for using case-based reasoning (CBR), an emerging artificial intelligence paradigm, to overcome this task. Developed Cases for building the system's case-base was generated using heuristic dynamic traffic assignment (DTA) model designed for region.

Evan Tan et.al., [4] proposed a novel approach of combining an unsupervised clustering scheme called Auto Class with Hidden Markov Models (HMMs) to determine the traffic density state in a Region Of Interest (ROI) of a road in a traffic video.

## III THEORETICAL BACKGROUND

### 3.1 PROBLEM IDENTIFICATION

The existing system proposes for controlling the traffic light by image processing. The vehicles are detected by the system through images instead of using electronic sensors embedded in the pavement. A camera will be placed alongside the traffic light. It will capture image sequences. Image processing is a better technique to control the state change of the traffic light. It shows that it can decrease the traffic congestion and avoids the time being wasted by a green light on an empty road. It is also more reliable in estimating vehicle presence because it uses actual traffic images. It visualizes the practicality, so it functions much better than those systems that rely on the detection of the vehicles' metal content.

### DISADVANTAGES

- A time-based traffic control system is one of the common methodologies or techniques to control traffic. But this methodology is contingent on time rather than on density. On account of this, the vehicles have to encounter an erratic delay in waiting time.
- The vehicles are made to wait even on the empty road in a time-based traffic control system which can again contribute congestion or traffic jam. Sensors can be used to detect vehicles and control traffic accordingly.
- But even in this method, the time is wasted by the green light on an empty road. Manual controlling engages the need for traffic police to change the traffic signals accordingly. This method also requires manpower.
- Although abundant methods are present already to control traffic, these methods can still bring on congestion due to disparate reasons. A traffic light control system based on the image processing technique can handle the problem of traffic congestion more effectively.

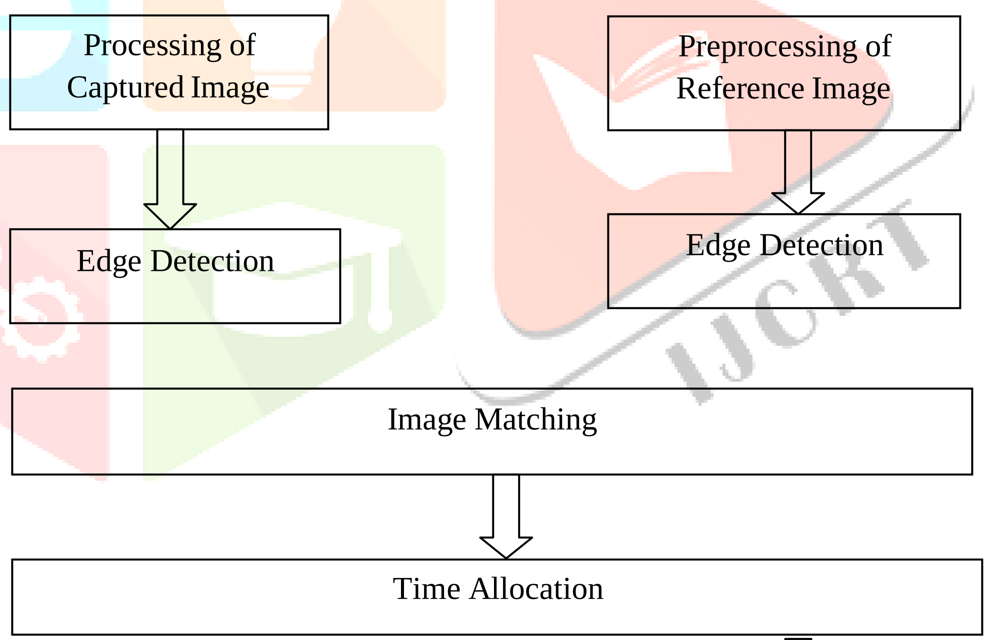
## 3.2 PROBLEM SOLVING

The proposed system helps in changing the traffic lights dynamically, which helps in reducing the congestion of the traffic and more importantly, allows smooth functioning of the traffic. The proposed system changes RGB images to Gray-Scale images for further processing. Canny Edge Detection Algorithm is used for the edge detection. Images are smoothed by applying Gaussian filter. At last, with the help of white point count, the density of the traffic is calculated for various lanes, which helps in varying the time of the traffic signals.

## ADVANTAGES

- It reduces the manpower required to operate the traffic signals.
- It reduces the need for additional hardware that might incur extra cost.
- Use faster algorithms that will not delay the system when used in real time.
- Dynamic traffic signal times to regulate traffic based on traffic density.

## 3.3 SYSTEM ARCHITECTURE




## IV SYSTEM IMPLEMETATION

### 4.1. PRE-PROCESSING OF CAPTURED IMAGE

Image pre-processing is performed to convert the raw images into more accessible form for edge detection. As Gray scale images have superior signal to noise ratio compared to RGB image, it is advantageous to convert RGB images into Gray scale for further processing. The following equation is used to convert each pixel in the image to its equivalent Gray scale form:

$$I = 0.3R + 0.59G + 0.11B$$

### 4.2. EDGE DETECTION

Edge detection is used to identify distinct shapes. It is used for isolating different shapes of the vehicles from rest of the image. After comparing different edge detectors, Canny Edge Detector is found to be most suitable for this application. Images are smoothed by applying Gaussian filter to reduce unwanted texture and details. The Canny Edge Detection algorithm can be broken down into the five following steps:

- Apply Gaussian filter to smoothen the image in order to remove the noise
- Find the intensity gradients of the image
- Apply non-maximum suppression to get rid of spurious response to edge detection
- Apply double threshold to determine potential edges
- Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

The Canny algorithm contains a number of adjustable parameters, which can affect the computation time and effectiveness of the algorithm.

- The size of the Gaussian filter: the smoothing filter used in the first stage directly affects the results of the canny algorithm. Smaller filters cause less blurring, and allow detection of small, sharp lines. A larger filter causes more blurring, smearing out the value of a given pixel over a larger area of the image. Larger blurring radii are more useful for detecting larger, smoother edges – for instance, the edge of a rainbow.
- Thresholds: the use of two thresholds with hysteresis allows more flexibility than in a single-threshold approach, but general problems of thresholding approaches still apply. A threshold set too high can miss important information. On the other hand, a threshold set too low will falsely identify irrelevant information (such as noise) as important. It is difficult to give a generic threshold that works well on all images. No tried and tested approach to this problem yet exists.

## 4.3. WHITE POINT COUNTS

A white point is a set of values or that serve to define the color "white" in image capture, encoding, or reproduction. It is used to calculate the traffic density by comparing the number of white pixels to the number of black pixels. This gives an estimation of the traffic density in the lane.

## 4.4. TIME ALLOCATION

Time allocation is done based upon the white point count of the traffic on the road at that particular time. The number of white pixels of the edge detected image and total number of pixels gives the density percentage.

$$\%density = \frac{\text{No. of white pixelsTotal}}{\text{No. of pixels}}$$

- If the density is between 0 to 10% - green light is on for 10 seconds.
- If the density is between 10 to 50% - green light is on for 30 seconds.
- If the density is between 50 to 70% - green light is on for 40 seconds.
- If the density is between 70 to 90% - green light is on for 60 seconds.
- If the density is between 90 to 100% - green light is on for 90 seconds.

## 4.5 IMAGE MATCHING TECHNIQUE

In this study, feature based matching technique is used to calculate the percentage of image that match between the two images. The result from the percentage of the image matching is used to identify which lane should be prioritized of having the longest duration of green signal. Figure 8 shows the output of image matching. Lane 2 and lane 3 show higher percentage of matching means that the presence of vehicles is low. While lane 1 and lane 4 show lower percentage of matching indicates that the presence of vehicles in that particular lane is high. Therefore, longer duration of green signal will be given to lane 1 and lane 4 with lower percentage of image matching and otherwise. In general, the lower the percentage, the longer the duration of green signal should be given to that particular lane.

# V CONCLUSION & FUTURE WORK

## 5.1 CONCLUSION

The system presents a novel approach, based on Canny Edge Detection (CED) algorithm to construct a traffic management system, with the aim of improving the traffic conditions. In this proposed system, the images are captured at intersections, and then they are processed using CED algorithm. After that, the calculation of the density of the traffic is done using the white point count, and dynamically the signal times are changed depending on the intensity of traffic. Therefore, the system autonomously controls the traffic, involving lower human power with virtually no new installation cost. This model is an attempt to detect the density of vehicles on road in real time. The implementation of the proposed system will help in attaining great accuracy. The increase in accuracy for the tested dataset will help a lot by avoiding the traditional edge detection methodology, which are not so effective in achieving the proper traffic management. Moreover, this will also contribute in a much faster overall computing process.

## 6.2 FUTURE WORK

The focus shall be to implement the controller using DSP as it can avoid heavy investment in industrial control computer while obtaining improved computational power and optimized system structure. The hardware implementation would enable the project to be used in real-time practical conditions. In addition, I have propose a system to identify the vehicles as they pass by, giving preference to emergency vehicles and assisting in surveillance on a large scale.

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