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TRAFFIC CONGESTION CONTROL OF VEHICLES BASED ON EDGE DETECTION USING IMAGE PROCESSING

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ABSTRACT: This paper is used to determine the traffic congestion on the roads based on the total number of the vehicles in the lane. It is possible to propose a dynamic time-based coordination scheme where the green signal time of the traffic lights is set based on the current traffic conditions. The main objective is to avoid traffic congestion and perform edge detection effectively using Canny Edge Detection. To calculate the density by subtracting foreground and background image from the total area of vehicles. Based on the number of the vehicles the green signal is set for the allocated time. This density will be calculated in terms of percentage (%).The major advantage of this system is the adaptation of the cycle period to the entire region's traffic profile. Avoids the time being wasted by a green light on an empty road. Flexible as it adjusts the timing of traffic lights according to the actual road condition Obstacle avoidance to avoid inconvenience.

Keywords: Traffic Congestion, Edge Detection, Image Processing, Canny Edge Detection

INTRODUCTION

In modern life we have to face with many problems one of which is traffic congestion becoming more serious day after day. It is said that the high tome of vehicles, the scanty infrastructure and the irrational distribution of the development are main reasons for augmented traffic jam. The major cause leading to traffic jam is the high number of vehicle which was caused by the population and the development of economy. To unravel this problem, the government should encourage people to use public transport or vehicles with small size such as bicycles or make tax on personal vehicles. Particularly, in some Asian countries such as Viet Nam, the local authorities passed law limiting to the number of vehicles for each family [1]. The methods mentioned above are really efficient in fact. That the inadequate infrastructure cannot handle the issue of traffic is also a decisive reason. The public conveyance is available and its quality is very bad, mostly in the establishing countries. Besides, the highway and roads are incapable of meeting the requirement of increasing number of vehicle. Instead of working on roads to accommodate the growing traffic various techniques have been devised to control the traffic on roads like embedded controllers that are installed at the junction. These techniques are briefly described in next section.

A Standard Traffic Control Systems

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.

B Drawbacks

In the manual controlling system we need more man power. As we have poor strength of traffic police we cannot control traffic manually in all area of a city or town. So we need a better solution to control the traffic. On the other side, automatic traffic controlling a traffic light uses timer for every phase. Using electronic sensors is another way in order to detect vehicles, and produce signal that to this method the time is being wasted by a green light on an empty road. Traffic congestion also occurred while using the electronic sensors for controlling the traffic. All these drawbacks are supposed to be eliminated by using image processing [3].

C 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.

1 LITERATURE SURVEY

1.1 Introduction

This chapter deals with the literature survey of digital image processing and applications of the image processing using different techniques. This chapter also describes the literature survey on MATLAB based image processing traffic applications, literature survey on traffic based Image processing applications. From the elaborated literature survey the motivations for the present work is presented.

1.2 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].

SuezouNakadateet al [2] discussed the use of digital image processing techniques for electronic speckle pattern interferometry. 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 Antoniniet al [8] proposed a new scheme for image compression taking psychovisual features in to account both in the space and frequency domains. This new method involved two steps. First, a wavelet transform in order to obtain a set of bi orthogonal subclasses of images; the original image is decomposed at different scales using a pyramidal algorithm architecture. Second, according to Shannon's rate distortion theory, the wavelet coefficients are vector quantized using a multi resolution codebook.

1.3 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 uncalibrated video images. The ability to use uncalibrated 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.

1.4 Background Subtraction

A video-based Intelligence Traffic System (ITS) must be capable of continuous operation under various road conditions. Moreover, background subtraction is a very important part of ITS applications for successful segmentation of objects from video sequences. Accuracy and computational time of the initial background extraction are crucial in any background subtraction method. Successful subtraction of foreground objects from a complex background scene is an important initial step in intelligent traffic systems applications.

Chung-Cheng Chiu et.al., [1] proposed the probability-based background extraction algorithm to segment objects from surveillance videos. With the proposed algorithm, the initial background can be extracted accurately and quickly by calculating the color probabilities of each pixel to decide the background pixel color. After the initial background extraction, the intrusive objects can be segmented correctly and immediately. Meanwhile, the color background images can be updated in real time to overcome any variation in illumination conditions.

Ren et.al., [2] proposed a background extraction method that involved calculating the mean of the background Gaussian distribution in the background map. Thongkamwitoon et. al.. [3] proposed statistical background subtraction methods that made the background extraction more robust to non-stationary backgrounds, illumination changes, and other artifacts, while Li et.al., [4] proposed a Bayesian framework that incorporated spectral, spatial, and temporal features to characterize the background appearance.

Yang Wang et.al., [5] presented an approach of moving vehicle detection and cast shadow removal for video based traffic monitoring. Based on conditional random field, spatial and temporal dependencies in traffic scenes are formulated under a probabilistic discriminative framework, where contextual constraints during the detection process can be adaptively adjusted in terms of data-dependent neighborhood interaction.

Cucchiara et.al.,[6] proposed to extract moving vehicles during daytime by means of motion extraction using frame-differencing algorithms and morphological operators, while at night time vehicles are identified by their headlights. For counting vehicles, moving objects must be extracted from images.

Prati et.al., [7] studied different algorithms for shadows detection. Normally shadows detection algorithms use colour information or some probabilistic shadows model. After moving objects segmentation and shadows removal, vehicles are tracked using a Kalman filter in a tracking process.

Daniel et.al., [8] presented the background subtraction and modeling technique that estimates the traffic speed using a sequence of images from an uncalibrated camera. The combination of moving cameras and lack of calibration makes the concept of speed estimation a challenging job.

Cheng et.al., [9] compare the performance of a large set of different background models on urban traffic video. They experimented with sequences filmed in weather conditions such as snow and fog, for which a robust background model is required.

1.5 Traffic incident detection

Intelligent classification methods can offer efficient ways to classify the state of the transport system.

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.

For real time traffic incident detection, Xu et.al., [3] have developed a real time on-line adaptive algorithm. The developed method consists of two stages. First a real time adaptive on-line procedure is used to extract the significant components of traffic states, namely, average velocity and density of moving vehicles. Second, a neural network called fuzzy CMAC (Cerebellar Arithmetic Computer) has been applied to identify traffic incidents. CMAC consists of both fuzzy logic unit and neural network unit. The system will help drivers to select an optimum route, it will be able to provide information for efficient dispatching of emergency services and moreover, it will provide accurate knowledge of existing traffic conditions.

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

1.6 Traffic control

Traffic control is one of the fast growing areas among the transport management problems. More efficient methods are needed for optimizing the road capacity and the traffic control systems. Traffic control involves different kind of problems for instance traffic signal and lights control, traffic assignment problems, scheduling and planning problems and so on. Traffic light control systems and intersection management systems seem to be the main issues under this problem area.

Intelligent techniques as a part of decision-making can be very effective. Fay [1] has developed a dispatching support system for use in railway operation control systems.

System contains expert knowledge in fuzzy rules of the “IF-THEN” type. Actually system is a fuzzy Petri net notion that combines the graphical power of Petri nets and the capability of fuzzy sets to model rule-based expert knowledge in a decision support system.

Correspondingly, Hegyi et.al., [2] have presented a fuzzy decision support system (FDSS) for assist the operators of the traffic control system. Fuzzy decision support system is part of a larger traffic support system and it can be used to provide a limited list of appropriate combinations of traffic control measures for a given traffic situation. The main role of the fuzzy decision support system is to suggest whether a particular local traffic controller or control measure should be activated or not.

Aid Decision-making fuzzy system is very useful because a lot of knowledge in the real situation concerning decision-making is uncertain. That was kept in mind when Aziz et.al., [3] developed a new strategy for the aid decision-making based on the fuzzy inferences in the traffic regulation of an urban bus network. The system helps operators of the urban bus network to solve the problem of connections between buses.

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

2 EXISTING WORKS & LIMITATIONS

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

2.1 Image Acquisition:

Generally an image is a two-dimensional function f(x,y)(here x and y are plane coordinates).The amplitude of image at any point say f is called intensity of the image. It is also called the gray level of image at that point. We need to convert these x and y values to finite discrete values to form a digital image. The input image is a fundus taken from stare data base and drive data base. The image of the retina is taken for processing and to check the condition of the person.

2.2 Formation of Image:

We have some conditions for forming an image f(x,y) as values of image are proportional to energy radiated by a physical source. So f(x,y) must be nonzero and finite. i.e. **$0 < f(x,y) < \infty$.**

2.3 Image Pre-Processing:

Image Resizing/Scaling:

Images are resized because of number of reasons but one of them is very important in our project. Every camera has its resolution, so when a system is designed for some camera specifications it will not run correctly for any other camera depending on specification similarities. So it is necessary to make the resolution constant for the application and hence perform image resizing

RGB to GRAY Conversion:

Humans perceive color through wavelength-sensitive sensory cells called cones. There are three different varieties of cones, each has a different sensitivity to electromagnetic radiation (light) of different wavelength. One cone is mainly sensitive to green light, one to red light, and one to blue light. By emitting a restricted combination of these three colours (red, green and blue), and hence stimulate the three types of cones at will, we are able to generate almost any detectable colour. This is the reason behind why colour images are often stored as three separate image matrices; one storing the amount of red (R) in each pixel, one the amount of green (G) and one the amount of blue (B). We call such colour images as stored in an RGB format.

2.4 Edge detection techniques

Different colours have different brightness values of particular colour. Green image has more bright than red and blue image or blue image is blurred image and red image is the high noise image.

Following are list of various edge-detection methods:-

a) Sobel Edge Detection Technique
b) Perwitt Edge Detection
c) Roberts Edge Detection Technique
d) Zerocross Threshold Edge Detection Technique
e) Canny Edge Detection Technique

2.5 Sobel Edge Detection Technique

The sobel operator is very similar to Prewitt operator. It is also a derivate mask and is used for edge detection. Like Prewitt operator sobel operator is also used to detect two kinds of edges in an image:

a) Vertical direction
b) Horizontal direction

2.6 Limitations:

a) In the existing system, the image processing is done by a static camera and thus the time duration for finding capturing the image and processing it is high.
b) Due to the continuous use of capturing and processing the image and comparing with the other lanes, there may be some inefficiency in the overall work.
c) The image captured by the static camera may not be dynamic.
d) The edge detection used is Sobel Edge detection, it may not give the accurate number of vehicles density.
e) If two vehicles are next to each other, by using Sobel edge detection the existing system may consider that as a single vehicle.
f) Due to the multiple captured images that are being processed, the process of implementing this technique will take long time.
g) So the major drawback of the existing system is due to the static camera and the Sobel edge detection.

3. PROPOSED WORK

In our proposed work, we change the static camera which is being used in the existing system into the video camera. The images are captured in the form of video frame inputs. We use the Video Object Detector to capture the video frame as input. By using this video object detector the input videos is converted into number of frames.

3.1 BLOCK DIAGRAM

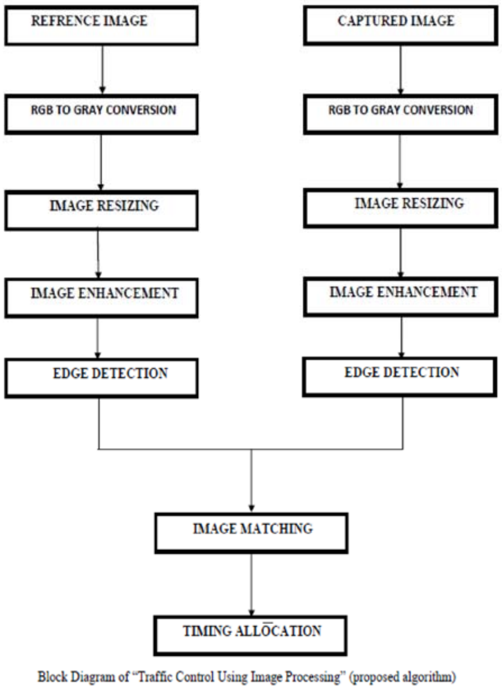

Fig 4.1 Block Diagram of "Traffic Control Using Image Processing" (proposed algorithm)

The Block diagram above gives an overview of how traffic will be controlled using image processing. Various boxes in Block diagram are explained below:

Identifying moving objects from a video sequence is a fundamental and critical task in many computer-vision applications. The following processes are employed

1. Image acquisition.
2. RGB to gray conversion.
3. Image enhancement.
4. Image matching using edge detection.

Image Acquisition:

Initially image acquisition is done with the help of web camera. First image of the road is captured, when there is no traffic on the road. This empty road's image is saved as reference image at a particular site specified in the program

RGB to Gray Conversion:

RGB to gray conversion is done on the progression of captured images. Now gamma correction is done on each of the captured gray image to achieve image enhancement.

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.

Image Matching Using Edge Detection:

Edge detection methods locate the pixels in the image that correspond to the edges.

Edge Detection:

Edge detection is a basic tool in image processing, machine vision and computer envisage, particularly in the areas of feature reveal and feature extraction. In our project we use "CANNY EDGE DETECTION TECHNIQUE" because of its various advantages over other edge detection techniques.

3.2 CANNY EDGE DETECTION

The Canny Edge Detector is one of the most commonly used image processing tools detecting edges in a very robust manner. It is a multi-step process, which can be implemented on the GPU as a sequence of filters. Canny edge detection technique is based on three basic objectives.

Low error rate:

All edges should be found, and there should be no spurious responses. That is, the edges must be as close as possible to the true edges.

Edge point should be well localized:

The edges located must be as close as possible to the true edges. That is , the distance between a point marked as an edge by the detector and the centre of the true edge should be minimum.

3.3 Advantages:

The major advantage of this system is the adaptation of the cycle period to the entire region's traffic profile. Avoids the time being wasted by a green light on an empty road. Flexible as it adjusts the timing of traffic lights according to the actual road condition Obstacle avoidance to avoid inconvenience.

4. EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Implementation Algorithm

The block diagram of the project was discussed in previous chapter. The algorithm behind the block diagram consists of following steps

The images are pre-processed as follows

a) Images are rescaled to 300x300 pixels.
b) Then the above rescaled images are converted from RGB to gray.
c) Edge detection of pre-processed images is carried out using Canny edge detection technique.
d) The output images of previous step are matched using pixel to pixel matching technique.

After matching the timing allocation is done depending on the count of the vehicles that are passed.

a) First the signal is set to red in all the lanes.
b) Then it is changed to yellow for 6 seconds in the entire lane.
c) If the number of vehicles that passed the rectangular box filter is Zero then the green signals is not set.
d) If the number of vehicles counted is 2 then the green light signal is opened for 10 seconds.
e) Similarly if the number of vehicles counted is 4 then the green signal is opened for 22 seconds.
f) If the vehicle count is more than 6 then the green signal is set to 30.
g) If the vehicle count is 10 then the green signal is set for 45 seconds.

The program written using MATLAB to implement the above algorithm is given in appendix however the output of each step and final results of the program are given in next sections.

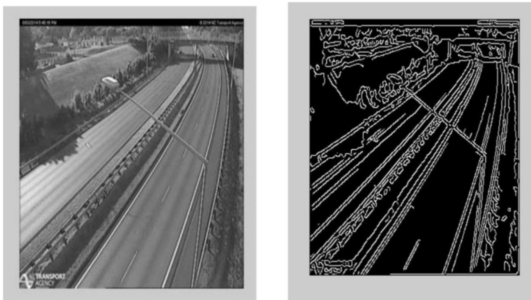

Fig 5.1 Gray reference image and Edge detected output of image.

Fig5.2 Gray captured image for comparison and Edge detected output

4.2 Results

The output of GUI given below clearly indicates the implemented results of the algorithm designed

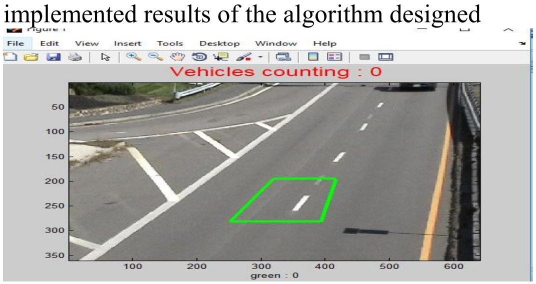

Figure 5.2 Reference image with the edge detector rectangular box.

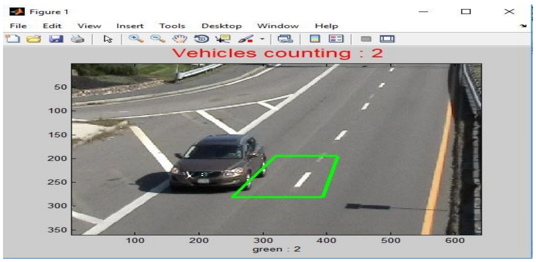

Figure 5.3b Edge detector rectangular box detecting the vehicle.

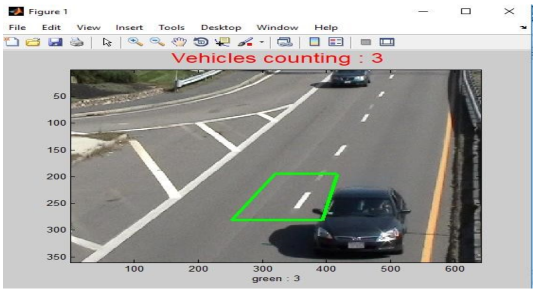

Figure 5.3c The vehicle counter incrementing the total count.

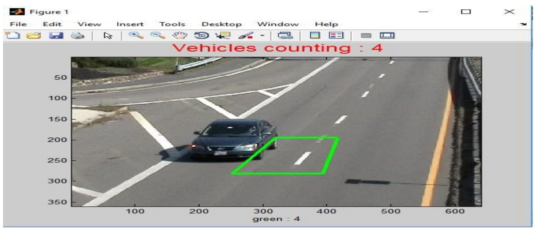

Figure 5.3d Total number of the vehicles detected.

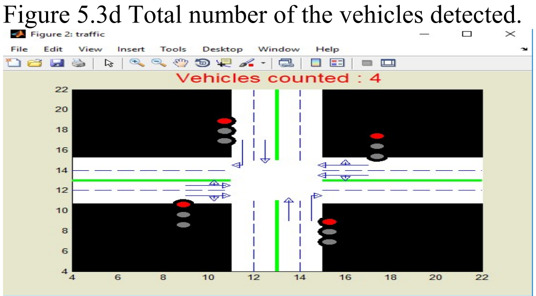

Figure 5.3e Traffic simulation starting with red signal in all lanes.

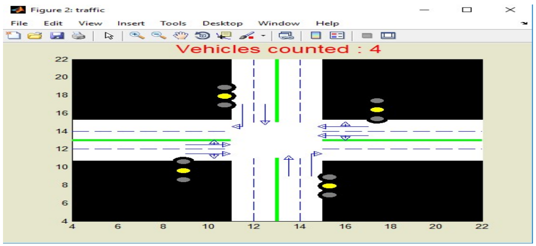

Figure 5.3f Traffic simulation with yellow in all lanes.

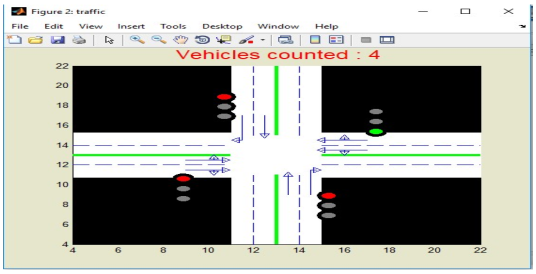

Figure 5.3g Traffic simulation, opening the green signal in the particular lane for the allocated time interval.

5. CONCLUSION

"Traffic control using image processing" technique that proposed in this system overcomes all the limitations of the earlier (in use) techniques used for controlling the traffic. Earlier in automatic traffic control use of timer had a drawback that the time is being wasted by green light on the empty. This technique avoids this problem. Upon comparison of various edge detection algorithms, it was inferred that Canny Edge Detector technique is the most efficient one. The project demonstrates that image processing is a far more efficient method of traffic control as compared to traditional techniques. The use of our technique removes the need for extra hardware such as sound sensors. The increased response time for these vehicles is crucial for the prevention of loss of life. Major advantage is the variation in signal time which control appropriate traffic density using Image matching. The accuracy in calculation of time due to single moving camera depends on the registration position while facing road every time. Output of GUI clearly indicated some expected results. It is shown that the signal is opened based upon the number of vehicles that crossed the rectangular Gaussian filter box in the road.

5.1 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, we 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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