Advance in Electronic and Electric Engineering.
ISSN 2231-1297, Volume 3, Number 8 (2013), pp. 987-1000

http://www.ripublication.com/aeee.htm

Vehicle Detection and Traffic Assessment Using Images

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Abstract

The work deals with automatic vehicle detection and classification based on image features. The real images of vehicles mainly 2 wheeler and 4 wheeler are captured using a digital camera with 10 MP. The image database includes 2 wheeler and 4 wheeler separately. The images are enhanced by resizing. Then region of interest (vehicle) is obtained to count. Mainly edge descriptors (canny) is applied to obtain vehicle contour/edges. The extracted vehicle region is cropped and subjected to feature extraction. The PGH (pair wise geometrical histogram) and edge features are used to represent the model of vehicle type. The PGH is a powerful shape descriptor which is used for polygonal shape. It also can applied to an irregular shape. Then these features are trained with neural network (NN). The test image is also processed in similar steps. Then the vehicle is classified as 2 or 4 wheeler based on input and trained features. The percentage of accuracy is reported. Later based on the region count and some predefined knowledge about traffic surveillance the traffic is assessed. Hence the work deals with automatic vehicle detection, classification and traffic surveillance in restricted vehicle count. The work can be enhanced by including sound and video surveillance and better feature extraction techniques.

Keywords: Traffic assessment, vehicle classification, vehicle count, DWT, PGH.

1. Introduction

As digital cameras and computers have become wide-spread, the number of applications using vision techniques has increased significantly. One such application that has received significant attention from the computer vision community is traffic surveillance. We propose a new traffic surveillance system that works without prior, explicit camera calibration, and has the ability to perform surveillance tasks in real time. Camera intrinsic parameters and its position with respect to the ground plane were derived using geometric primitives common to any traffic scène. Earlier work use optical flow and knowledge of camera parameters to detect the pose of a vehicle in the 2D/3D world. This information is used in a model-based vehicle detection and classification technique employed by our traffic surveillance application. Now days due to busy schedule of work style, the people are facing heavy traffic problem. This is also due to narrow road, improper traffic controllment by the controller & also due to avoiding rules & road signals. Hence a proper traffic management &traffic survey is very much necessary.

Traffic management is the planning, monitoring and control or influencing of traffic. The main purpose is to maximize the effectiveness of the use of existing infrastructure, ensure reliable and safe operation of transport, address environmental goals & ensure fair allocation of infrastructure space (road space, rail slots, etc.) among competing transporters. Hence an ITS is become an essential part of life to survive & better benefit, safety of human life.

Intelligent Transportation System (ITS) is an effective way to solve the traffic jam which is caused by rapid development of urbanization and automobile industry .Traffic monitoring system which based on the video image sequence is a combination of digital video images and artificial pattern recognition technology, and it analyzes the video images with characteristics of intuition, efficiency, wide detection range and high precision. Researchers proposed many methods to detect moving targets such as Background subtraction and Frame difference method , as well as a number of ways to tracking vehicles such as region-based ,dynamic contour , feature-based methods.

In present system vehicle recognition & classification is done using smart cameras, interception & video enabled computer based system. Present system also used video as input & using detectors, sensors which has drawbacks like high cost, slow response & more communication overhead for chaotic traffic. In order to reduce the death rate & accident rate, an automatic traffic surveillance system is necessary. Hence the proposed work classifies the vehicles as two/four wheeler based on edge/shape features. The images are classified using neuro classifier. The traffic surveillance/bottleneck is determined based on object count and threshold value. Future work can be carried by combining video/still images with acoustic/sound signal.

2. Related Work

G D Sullivan, K D Baker, A D Worrall, C I Attwood and P R Remagnino **(1997)** reported the current state of work to simplify our previous model-based methods for visual tracking of vehicles for use in a real-time system intended to provide continuous monitoring and classification of traffic from a fixed camera on a busy multi-lane motorway. The system developed uses three main stages: (i) pose and model hypothesis using1-D templates, (ii) hypothesis tracking, and (iii) hypothesis verification, using 2-Dtemplates. Stages (i) & (iii) have radically different computing performance and computational costs, and need to be carefully balanced for efficiency

A.N .Rajagopalan and R. Challapa **(2000)** have presented a scheme for vehicle detection and tracking in video. The method effectively combines statistical knowledge about the class of vehicles with motion of vehicles. Statistical learning and parameter estimation, moving object segmentation, object discrimination and tracking are used. The system effectively detects and tracks vehicles, even against complex backgrounds. The method is also reasonably robust to orientation, changes in scale and lightning conditions.

Surendra Gupte, Osama Masoud, Robert F. K. Martin**(2002)** presented algorithms for vision-based detection and classification of vehicles in monocular image sequences of traffic scenes recorded by a stationary camera. The system consists of segmentation ,region Tracking,recovery of Vehicle Parameters,vehicle Identification,vehicle Tracking &vehicle Classification steps.

Neeraj K. Kanhere Shrinivas J. Pundlik Stanley T. Birchfield**(2005)** presented a method to segment and track vehicles in low-angle situations. The technique is based upon tracking feature points throughout a block of frames from the image sequence, then grouping those features using several motion-related cues. They present a novel combination of background subtraction, extending plumb lines, and multi-level homography to determine the height of features using a constraint we call the relative height constraint.

Neeraj K. Kanhere**(2006)** presented a novel method for automatically visually monitoring a highway when the camera is relatively low to the ground and on the side of the road. In such a case, occlusion and the perspective effects due to the heights of the vehicles cannot be ignored. Using a single camera, the system automatically detects and tracks feature points throughout the image sequence, estimates the 3D world coordinates of the points on the vehicles, and groups those points together in order to segment and track the individual vehicles.

Xi Yong, Liwei Zhang, Zhangjun Song **(2011)** have used the Pairwise Geometrical Histograms (PGH) which is a generalization of Chain Code Histogram (CCH). It is a powerful shape descriptor that is applied to contours matching which is not affected by rotation. In recent years, the Violaand Jones rapid object detection approach became very popular .In this work, they combine the Haar features and PGH together for vehicle detection. They discussed the vehicle detection using only Haar features, Haar features combined with huf moments and Haar features combined with PGH methods.

Vikramaditya Dangi, Amol Parab, Kshitij Pawar & S.S Rathod **(2012)** proposed to implement an intelligent traffic controller using real time image processing. The image sequences from a camera are analyzed using various edge detection and object counting methods to obtain the most efficient technique. In case an emergency vehicle is detected, the lane is given priority over all the others. The method tries to evaluate the process and advantages of the use of image processing for traffic control. Thus the use of this technology is valuable for the analysis and performance improvement of road traffic. The use of algorithm removes the need for extra hardware such as sound sensors or RFID tags.

Nehal Kassem,Ahmed E. Kosba and Moustafa Youssef**(2011)** introduced a novel RF-based vehicle motion detection and speed estimation system (ReVISE). The purpose of ReVISE is to leverage common wireless networks, such as Wi-Fi or cellular, to detect the density of traffic and estimate the car speed based on the mobile devices carried by users. This gives an edge over the current techniques for traffic estimation as we do not require any specialized hardware and the cellular signal strength information is available from *all* cell phones, providing large-scale ubiquitous traffic estimation.

Jorge badenas and filiberto pla**(2010)** have proposed the approach which is based on a region tracking algorithm since this type of method provides advantages. Region based methods provides groups of connected pixels that are detected as belong to the single object that is moving with different motion from its neighboring regions. Region tracking is less sensitive to occlusion due to extensive information that regions supply. Moreover regions are very suitable for scenes with stationary background, since motion estimated for regions, allow to separate moving regions from stationary regions.

Soo Siang Teoh and Thomas Bräu*n*l **(2012)** introduced a technique for tracking the movement of vehicles in consecutive video frames. The technique is based on a Kalman filter and a reliability point system. The Kalman filter predicts the most probable location of a detected vehicle in the subsequent video frame. This information is used by the tracking function to narrow down the search area for re-detecting a vehicle. The Kalman filter also helps to smooth out the irregularities due to the measurement error. The reliability point system provides a simple and fast mechanism to monitor the quality of tracking for the vehicles in the tracking list. Each vehicle is assigned with a reliability point, which can be increased or reduced at every tracking cycle depending on how consistent the vehicle is being re-detected.

3. Proposed System

The proposed system contains the following modules as shown in “Fig 1”.

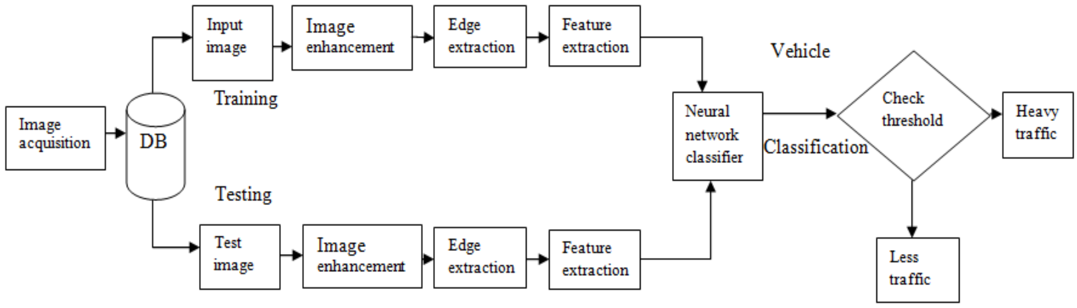

Fig. 1: Proposed system design.

Proposed system consists of training phase & testing phase. Our proposed system consists of modules named image acquisition, input image, image enhancement, edge extraction & feature extraction.

4. Image acquisition :

Image acquisition in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. One of the ultimate goals of image acquisition in image processing is to have a source of input that operates within such controlled and measured guidelines that the same image can, if necessary, be nearly perfectly reproduced under the same conditions so anomalous factors are easier to locate and eliminate. Image should be collect by reducing the speed, as fast moving vehicles cannot be captured using cameras. In our work image is captured using sony cyber shot digital camera of 8MP, the high mega pixels of camera has good clarity of image. In this work, our database consists of three different class of images like images of only two wheelers, images of only four wheelers & images combining both two & four wheelers.

5. Input image

Here in this module we take the image from the database and we pass it to the next module for further processing. Here we can passing an image of any class from our database collection.

Fig. (a) image of four wheeler fig(b) image of two wheeler fig (c) image of both

6. Image enhancement

Image Enhancement involves the modification of digital data for improving the image qualities with the aid of computer. The processing helps in maximizing clarity, sharpness and details of features of interest towards information extraction and further analysis. The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application. Due to wind, road pollution & heavy shutter of camera, the captured image may not be clear & may not be suitable for further processing, hence the captured image must be enhanced before passing it to the next module.

Most interpreters are concerned with recognizing linear features in images such as joints and lineaments. Geographers map manmade linear features such as highways and canals. Some linear features occur as narrow lines against a background of contrasting brightness; others are the linear contact between adjacent areas of different brightness. In all cases, linear features are formed by edges. Some edges are marked by pronounced differences that may be difficult to recognize. Contrast enhancement may emphasize brightness differences associated with some linear features. This procedure, however, is not specific for linear features because all elements of the scene are enhanced equally, not just the linear elements. Digital filters have been developed specifically to enhance edges in images and fall into two categories: directional and non-directional.

7. Edge extraction

Edges are those places in an image that correspond to object boundaries. Edges are pixels where image brightness changes abruptly. An edge is a property attached to an individual pixel and is calculated from the image function behavior in a neighborhood of the pixel. It is a vector variable (magnitude of the gradient, direction of an edge).

Edge Detection Edge information in an image is found by looking at the relationship a pixel has with its neighborhoods. If a pixel’s gray-level value is similar to those around it, there is probably not an edge at that point. If a pixel’s has neighbors with widely varying gray levels, it may present an edge point.

Edge Detection Methods

Many are implemented with convolution mask and based on discrete approximations to differential operators. Differential operations measure the rate of change in the image brightness function. Some operators return orientation information. Other only return information about the existence of an edge at each point. The canny edge extraction method is used in the work.

The Canny Edge Detection Algorithm

The algorithm runs in 5 separate steps

1. Smoothing: Blurring of the image to remove noise.
2. Finding gradients: The edges should be marked where the gradients of the image has large magnitudes.
3. Non-maximum suppression: Only local maxima should be marked as edges.
4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.

Fig: input image

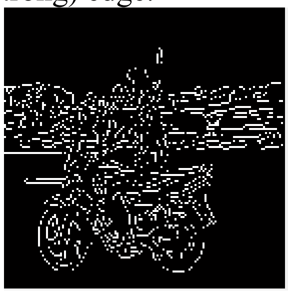

Fig: edge extracted image

8. Feature extraction

We have used DWT(discrete wavelet transform) & PGH (pairwise geometrical histogram) , entropy, standard deviation, mean & co-variance features

DWT

Dwt is the algorithm used to reduce dimensionality of image so it used for image compression, feature extraction process. DWT algorithm decomposes the image into 4 sub-band (sub-image) ie ,LL,LH,HL,HH. Dwt output extracts the detailed output of input image. LL is the approximate image of input image it is low frequency sub-band so it is used for further decomposition process. LH sub-band extract the horizontal features of original image HL sub-band gives vertical features HH subband gives diagonal features.

9. Pairwise geometrical histogram

PGHs are defined for linear edge segments, encoding the relative (perpendicular) positions and orientations of any other linear edge segments in a specified local image region (Figure 2). Since any curved edge can be approximated, to a desired degree of precision, by line segments , PGHs can encode arbitrary local image shape in a form amenable to computerised analysis. Shape recognition is performed by searching for correspondence between sets of learned representative object histograms and image sampled ones. As indicated in Figure 2, the use of perpendicular distance and orientation means that the sample line is effectively free to shift back and forth along the reference line, within the bounds of the sample zone without changing the histogram entries. Though a second orthogonal spatial ordinate could be encoded to unambiguously represent any edge configurations (essentially amounting to a fixed edge template), this would require a fixed point of reference, which simply cannot be assumed under typical viewing conditions for edge features (in accordance with the 'aperture problem').

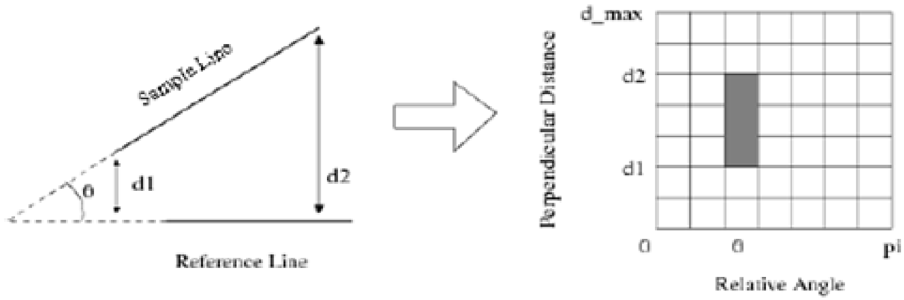

Fig 2 : The relationship between a pair of image lines can be detailed by the angle θ (defined at their point of intersection) & two perpendicular distances

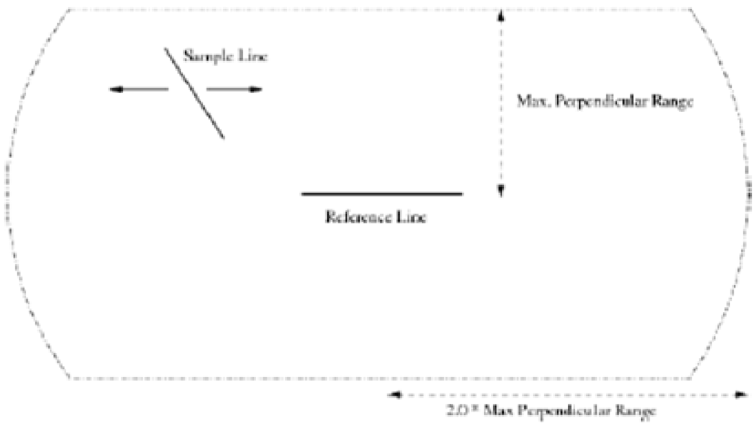

Fig. 3 : According to the pairwise relationship detailed in fig 2, sample lines are free to shift along an axis running parallel to the reference line.the dotted border indicates the range through which the lines are *sampled for inclusionto the reference line's PGH*

The PGH representation can be made fully (image-plane-) rotation invariant, by essentially adding rotationally equivalent contributions from each side of the reference line to the same histogram bins. The reference line is assigned a direction pointing away from the point of intersection with each sample line, allowing a signed perpendicular axis to be defined and relative angle to be inferred, as indicated in Figure 3. Any intersecting lines are split at the point of intersection and are treated independently. While sample lines are otherwise free to displace laterally without affecting the representation (see Figure 3), this new constraint limits such displacements up to the point at which the intersection meets the reference line. This is because the polarity of part of the reference line will swap as the intersection point crosses it, so that histogram entries will switch into the opposite distance axis. Such rotational invariance cannot however be achieved without some loss of recognition specificity. To overcome this, if required, the reference line can be assigned an arbitrary direction, so that PGH entries are assigned relative to which side of the directed reference line they emanate from. The trade off here is that each image line will require analysis in each direction independently.

10.Standard deviation, entropy, variance

The standard deviation s of a data vector x is given by

$$\textbf{(1)}\quad s = \left(\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{x})^2\right)^{\frac{1}{2}}$$

$$\textbf{(2)}\quad s = \left(\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2\right)^{\frac{1}{2}}$$

Where

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n}x_i$$

Where n is the number of elements in sample. The two forms differ only in n-1 verses n in the divisor

The variance of M by N matrix is the square root of standard deviation

$$y = \sigma^2 = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left|u_{ij}\right|^2 - \frac{\left|\sum_{i=1}^{M}\sum_{j=1}^{N}u_{ij}\right|^2}{M*N}}{M*N-1}$$

Entropy is the statistical measure of randomness that can be used to characterize the texture of input image. Entropy is defined as

Sum (p.*log2(p))

Where p contains the histogram counts returned from imhist.

11.Training in neural network

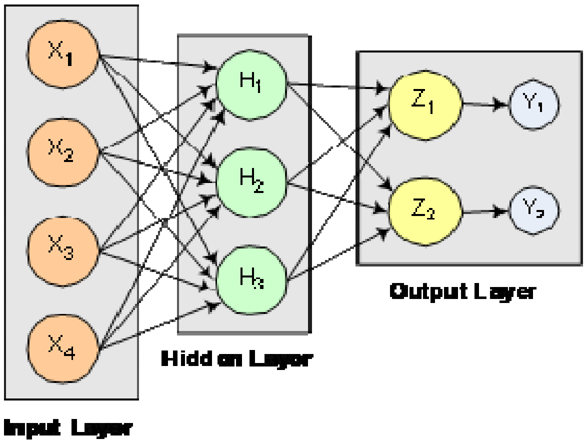

Fig. 4: A 2-layer, Feedforward Network with 4 inputs and 2 outputs.

A neural network is defined not only by its architecture and flow, or interconnections, but also by computations used to transmit information from one node or input to another node. These computations are determined by network weights. The process of fitting a network to existing data to determine these weights is referred to as training the network, and the data used in this process are referred to as patterns. Individual network inputs are referred to as attributes and outputs are referred to as classes.

In the testing phase of the design, we first take a sample input image then we follow all steps from image enhancement to feature extraction. The extracted features are then compared with the trained features. Based on the result the vehicle in the given input image is classified as two wheeler or a four wheeler.

Algorithm:

1) Read the image from the users.
2) Apply 2D DWT using discrete wavelet over the image.
3) Obtain horizontal, vertical, diagonal & approximate coefficients.
4) Display the resulting image of all four sub-bands.
5) Compute entropy, covariance, standard deviation feature values.
6) Store all features in a library & train the neural network.
7) The neural network parameters like learning rate of 0.04, epochs = 7000,20 input features, three output class are adopted.

Vehicle count

The number of vehicles in the input image is counted with the help of region counting method. We set a threshold value for assessing traffic, based on this threshold value the traffic is assessed by comparing the count of vehicle in the image & threshold value. If count value is greater than threshold the output will be heavy traffic(congested) or else output will be no traffic.

12.Results & discussion

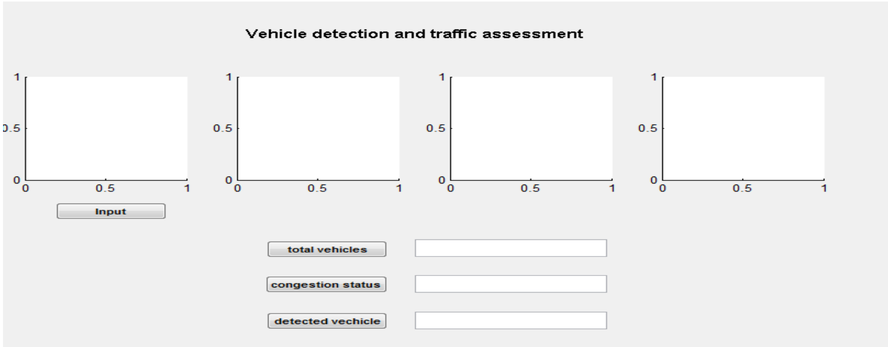

Fig. 5: GUI of the proposed system.

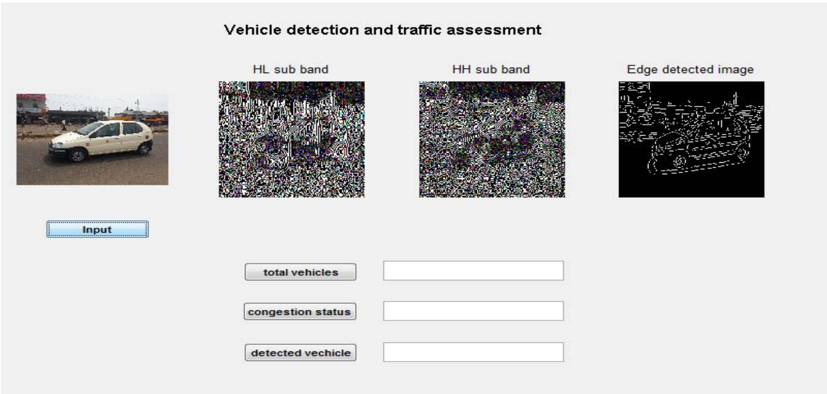

Fig. 6: result of the edge extraction.

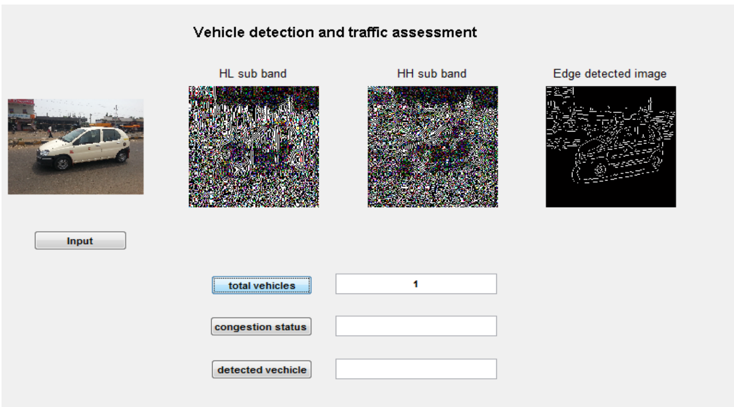

Fig. 7: result showing vehicle count.

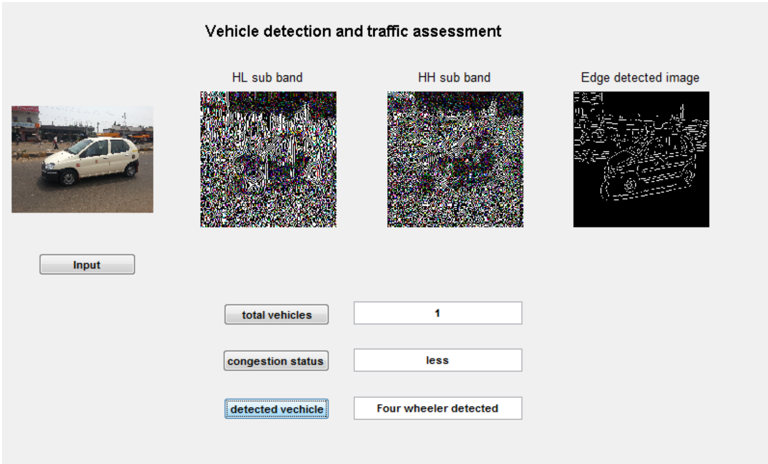

Fig. 8: result showing vehicle class & congestion status.

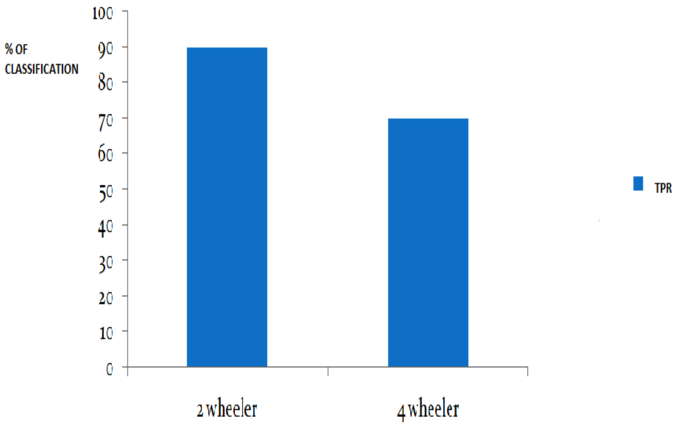

Fig. 9: graph showing the percentage of classification.

13.Conclusion:

The work presented a traffic surveillance system that identifies, classifies and tracks vehicles. The system is general enough to be capable of detecting, tracking and classifying vehicles while requiring only minimal scene specific knowledge. We developed and used feature based object detection and classification techniques, The benefit of using this technique is that it is fast , compared to the different strategies suggested in the literature.

The proposed work classifies object (vehicle) as two wheeler or four wheeler based on edge/shape features. The traffic surveillance/bottleneck is determined based on object count and probable estimated size of road. The work can be enhanced by including road parameters, additional features, and images of more vehicles & can be combined with video signals.

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