Available online www.ejaet.com

European Journal of Advances in Engineering and Technology, 2015, 2(6): 70-76

Research Article ISSN: 2394 - 658X

Vehicle Detection and Classification in Low Vision Video Footage

Umesh and Satbir Singh

Department of Electronics & Communication Engineering,
Shaheed Udham Singh College of Engineering and Technology, Tangori, Mohali, Punjab, India
erumeshdawra@gmail.com

ABSTRACT

This proposed research work describes a system that is used for recognition and classification of vehicles from low vision video footage captured by surveillance cameras. It's an important step for many applications in intelligent transportation systems and video surveillance. For carrying out the above said process, first step is detection of the vehicles present in the enhanced video frame & then classification of a particular vehicle based on vehicle features like color, shape and corner points in the video. An innovative method is proposed for recognizing the vehicle present in the video. At first, enhancement of the low/night vision footage is done. After it, the features are extracted. Color is extracted using RGB color values of the vehicle, Shape is extracted based upon Zernike moments & for Corner detection, Harris corner detector process is applied. Finally the Fuzzy Inference system takes the help of extracted features to classify the type of vehicle.

Key words: Enhancement, Color Recognition, Zernike moments, Harris detector and Fuzzy inference system

INTRODUCTION

Vehicle detection & classification is an important task for identifying a specific vehicle in a digital image or in a video. It's an important aspect of common day video surveillance systems. Video surveillance systems have long been in use to monitor security sensitive areas. In the past, to detect the vehicle from the video frame sequence, the vehicle motion is detected and tracked along the frames using Optical Flow Algorithm and Background Subtraction technique [1]. Recently for the recognition of vehicle, different features are extracted from video frames like shape is extracted using moments, logo using the Scale Invariant Feature Transform (SIFT) and the RGB color values of the car body & using fuzzy Adaline neural network the recognition is carried out to classify the type of car [2]. For the classification of vehicle, color is the significant attribute to determine exterior of vehicle. Recently, for recognize the color of vehicle; Vehicle Color Recognition System is the implementation of automatic detection of predominant color of vehicles from the traffic images captured through CCTV cameras installed at crossings [3]. Vehicle detection & classification play an important role for many applications such as civilian and military applications where a particular scene of area requires monitoring to avoid terrorist attacks and unauthorized entries. Recently, Vehicle detection process on road are used for vehicle tracking, counts, average speed of each individual vehicle, traffic analysis and vehicle categorizing objectives and may be implemented under different environments changes [4]. However, the traditional vehicle systems may be not recognized well due to the vehicles are occluded by low vision frames such as blurred frames & night vision frames etc., and in this paper for the better performance of vehicle detection & classification these irregularities removed from night vision footage to extracting features by Video enhancement.

In this paper, the traffic image analysis comprises of four parts: (1) Enhancement (2) Color recognition using RGB values (3) Corner detection using Harris corner detector (4) Shape detection using Zernike moments. The in-depth of the paper is as follows: It explains the Color recognition using RGB values after that it describes Harris corner detector then it describes shape detection using Zernike moments, after Zernike moments it discusses the proposed methodology, then Results are Discussed and presented and finally concludes the paper.

ENHANCEMENT

Image enhancement is a pre-processing step in many image processing applications. The aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide better input for other automated image processing techniques. [5] There are various reasons for poor quality of an image such as distortion being introduced by the imaging systems, lack of expertise of the operator or the adverse external conditions at the time of image acquisition. Mainly, Image enhancement includes intensity and contrast manipulation, noise reduction, edges sharpening and filtering, etc. Contrast Enhancement is focused on the problem of improving the contrast in an image to make various features more easily perceived. Contrast of an image is determined by its dynamic range, which is defined as the difference between lowest and highest intensity level. Contrast enhancement techniques have various application areas for enhancing the visual quality of low contrast images. Many contrast enhancement algorithms have been developed over the years. Contrast enhancement algorithms can broadly be divided into two categories: spatial domain techniques and frequency domain techniques.

In spatial domain techniques, the image enhancement is based on direct manipulation of the pixels in an image. Frequency domain processing techniques are based on modifying the Fourier transform of an image. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are then performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image.

Histogram Equalization

In this paper, for enhancing the dark portions of image, techniques based on histogram are useful. Histogram Equalization is a technique which enhances the global contrast of an image. This technique is very useful especially when the usable information data of the image is represented by close contrast values. With this adjustment, the intensities can be better distributed on Histograms. Hence HE flattens the density distribution of the resulting image. HE is useful in images with more bright or darker backgrounds or images clicked in night with flash. The main advantage of this technique is that if the histogram equalization function is known, then original histogram can be recovered using the function. The limitation of this technique is that it may increase the contrast of the background noise, while decreasing the information signal, since its straight use can change the original brightness of input image and deteriorate visual quality [6].

COLOR RECOGNITION USING RGB VALUES

Vehicle Color is the significant attribute of the individual to get identified in the video frames. It is important task especially for Intelligent Transportation System (ITS) and also most important factor to determine exterior of vehicle. In this paper for the color recognition of the vehicle, we are using RGB values of each pixel of the vehicle. Basically Vehicle Color Recognition is the implementation of automatic detection of predominant color of vehicles from the low vision frames captured through cameras. This step presents a new effective method for extracting color of vehicle using MATLAB, Firstly vehicle is cropped from the video frame and then color of individual vehicle is picked according to the probability of frequency of RGB values of each pixel and the color is presented as vehicle color in the output.

CORNER DETECTION USING HARRIS CORNER DETECTOR

In simpler terms, a corner can be defined as the intersection of two edges. Generally corners in video frames represent a lot of important information and also it is the important aspect of local features in video frames. In this paper for the corner detection of the vehicle, Harris corner detector is applied, it's a well-known interest key point detector due to its invariance to rotation, illuminations and variation which has been proposed in 1988. Harris corner detector [7] is based on the local auto-correlation function of a signal which measures the local changes of the signal with patches shifted by a small amount in different directions.

The steps to implement Harris corner detection are:

Input: Gray scale image I(x, y)

Output: Interest (corner) points

Step: 1 Apply image smoothing using averaging filter

Step: 2 Compute magnitude of the x and y gradients at each pixel

Step: 3 Construct C in a window around each pixel, where C is autocorrelation matrix. Ix and Iy are derivative of image I.

$$C = \begin{bmatrix} \sum I_x^2 & \sum I_x I_y \\ \sum I_x I_y & \sum I_y^2 \end{bmatrix} = \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix} \tag{1}$$

Step: 4 calculate cornerness (R**)** measure using below eq. 2

$$R = Det(C) - k * (TC)^2 \tag{2}$$

Det. is determinant of the matrix C. T is the trace of the matrix. R is for the value of the corresponding pixel of interest – λ1; λ2 is proportional to the principle curvatures of partial autocorrelation function. Therefore, by judging the value of λ1 and λ2 to determine the slow changes of areas, corners and edge. The changes are the three cases:

1. If λ1 ≈ 0 and λ2 ≈ 0, then this pixel (x,*y*) has no feature interest.
2. If λ1 ≈ 0 and λ2 has some large positive value, then an edge is found.
3. If λ1 and λ2 have large positive values, then corner is found [7][8]

SHAPE DETECTION USING ZERNIKE MOMENTS

In general, moments defined as numeric quantities at some distance from an axis or reference point. It can also be used as a feature extraction technique. Moment is a certain particular weighted average of the image pixels, intensities, usually chosen to have some attractive property or interpretation [9].In this paper for the shape detection of the vehicle, Zernike moment is applied. Zernike moments are often used efficiently as powerful shape descriptor in terms of robustness and description capability .It is used for describing various shapes of patterns. They have rotational invariant properties, robustness to noise, expression efficiency, and multi-level representation but they do not have scale and translation invariance properties.

The Zernike moments introduce a set of complex polynomials which form a complete orthogonal set over the interior of a unit circle, *i.e.,* $x2 + y2 \leq 1$ [9]. In fact Zernike moments are the projection of the image function on some orthogonal basis functions. Let the set of these basis functions be denoted by $Vn,m(x, y)$. These polynomials are defined by [9]

$$V_{n,m}(x,y) = V_{n,m}(\rho,\theta) = R_{n,m}(\rho)e^{jmp} \quad (3)$$

Where n is a non-negative integer, m is a non-zero integer subject to the following constrain: $n - |m|$ is even and $|m| < n$. Also, ρ is the length of the vector from origin to the (x, y) pixel, θ is the angle between vector ρ and x-axis in a counter-clockwise direction, and $Rn,m(\rho)$ is the Zernike radial polynomial. The Zernike radial polynomials, $Rn,m(\rho)$, are defined as [9]:

$$R_{n,m}(\rho) = \sum_{s=0}^{\frac{n-|m|}{2}} \frac{(-1)^s(n-s)!}{s!\left(\frac{n+|m|}{2}-s\right)!\left(\frac{n-|m|}{2}-s\right)!}\rho^{n-2s} \quad (4)$$

Note that $Rn,m(\rho) = Rn,-m(\rho)$. The Zernike moment of order n with repetition m for a digital image is [9]

$$Z = \frac{n+1}{\pi}\sum\sum_{x^2+y^2\leq 1} f(x,y)V^*_{n,m}(x,y)\Delta x\Delta y \quad (5)$$

Where $V^*\, n,m(x, y)$ is the complex conjugate of $Vn,m(x, y)$. To compute the Zernike moments of a given image, the image center of mass is taken as the origin.

METHODOLOGY

The complete procedure is shown in the flowchart (Fig. 1) & Fig.2 shows block diagram of fuzzy inference system.

Low Vision Video Footage Containing Vehicles as Input

Sometime low vision video For the Detection of the vehicles the first step is obtaining a low-slung vision footage comprising vehicles as an input. In this paper, the video is shoot in the winter season at approx. 06.52 PM using standard 2 megapixel cameras from a mobile so that the required condition is successfully met.

Frame extraction

Video footage consists of many frames and for the further processing, different frame is extracted from the Video footage.

Video & Contrast Enhancement

Sometime low vision video contains frames having very low quality/night vision or blurred images and for this problem, video & contrast enhancement must be done in prior to obtaining out the future processing. The aim of enhancement is to improve the visual appearance of a scene, or to provide a better transform representation for application of rest of techniques. In this paper, image equalization is used as a tool for low qualities frames. Basically image equalization is used to increase the contrast of the frames & its spreads the full intensity value on frames for the better visibility. In the process of image equalization, it's added only extra pixel to the light region of the frame & removes extra pixels from the dark region of the frames.

Contour Detection

After the enhancement of the frame, applied the contour detection for the marking of a particular vehicle that present in the obtained frame and the marked frame is used for the mining of different features, which is used for the classified the vehicle.

Feature mining for Detecting Vehicles

To detect features from contour frames is based upon different technologies like Corner Points using Harris Corner Detector and Shape using Zernike moments.

Fuzzy Inference System

The final step is Classification based upon vehicle feature for the identification of the type of vehicle like vehicle color, comer points and shape with the help of Fuzzy Inference system. Fuzzy inference system (FIS) is a method, based on the fuzzy theory, which maps the input values to the output values and the mapping mechanism is based on some set of rules(if-then statements).

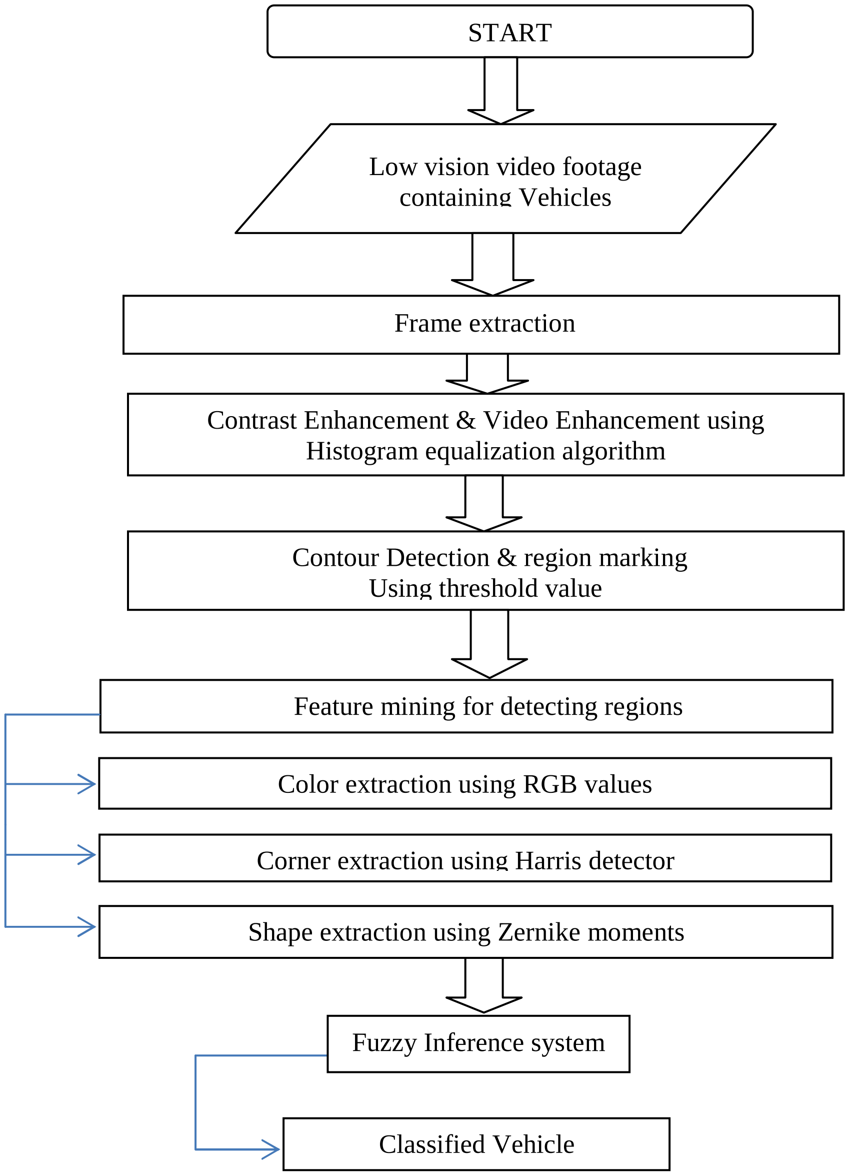


Fig.1: Diagram of the proposed technique

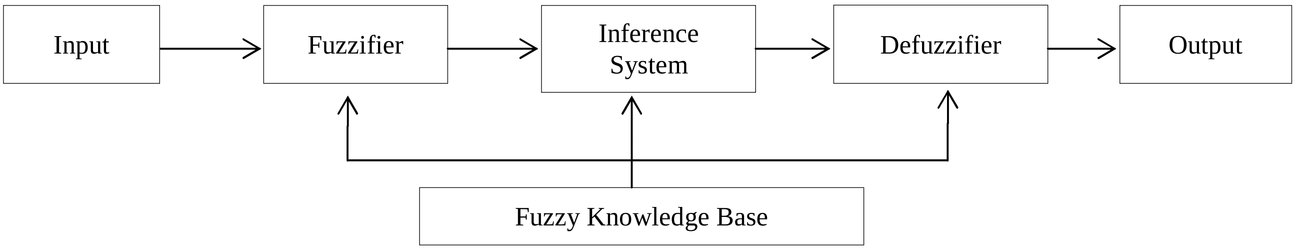


Fig.2: Fuzzy Inference system

Input

For the Detection of the vehicles the first step of Fuzzy inference system is taking low vision frames containing vehicles as an input.

Fuzzifier

The next step of the system is fuzzification through fuzzifier that converts the crisp input to a linguistic variable using the membership functions stored in the fuzzy knowledge base.

Inference System

After the fuzzification, use IF-THEN type fuzzy rules in inference system that converts the fuzzy input to the fuzzy output.

Defuzzifier

Defuzzifier converts the fuzzy output of the inference system to crisp using membership functions analogous to the ones used by the fuzzifier.

Output

The final step is OUTPUT that gives vehicle identification based on different features like vehicle color, comer points and shape of the vehicle.

RESULTS AND DISCUSSION

Firstly, the FIS system was made to learn using the feature values obtained from already available static images of six type of cars viz. Suzuki Alto, Hyundai i20, Suzuki Swift, Toyota Innova, Maruti 800 and Tata Indica. Then based upon the three features obtained from these types of cars, a rule list was prepared for the designing of the fuzzy system inference system. Table -1 & Table -2 show the range for these classes of cars experimentally and Table -3 show results of proposed algorithm & then after designing the fuzzy system with the help of above data obtained the system was tested for the low vision shooting obtained video footage. The results are shown in Fig. 3, Fig. 4, and Fig. 5.

Table-1 Range of Feature used to Design the Rule List for FIS

Name of the vehicle color	White color	light steel blue color	Firebrick color	light Grey color
Red color Values of the vehicle lies between	(250-255)	(182-208)	(105-90)	(206-211)
Green color Values of the vehicle lies between	(251-255)	(218-227)	(20-30)	(208-214)
Blue color Values of the vehicle lies between	(250-255)	(238-255)	(70-90)	(212-220)

Table-2 Range of Features used to Design the Rule List for FIS

Name of the Vehicles	**No. of Detected Corner points lies between**	**Zernike moments values(approx...) lies between on the basis of shape**
Suzuki Alto	11-12	0.0390-0.0450
Hyundai i20	12-13	0.0655-0.0850
Suzuki Swift	12-14	0.0460-0.0650
Tata Indica	11-13	0.0225-0.0350
Maruti 800	12-13	0.0100-0.0225
Toyota Innova	13-15	0.0250-0.0640

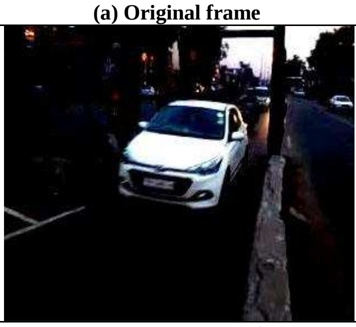
Table-3 Results of the Proposed Algorithm

Footage	**Total vehicles Present**	**Correctly classified**	**False Classified**	**Accuracy**
Footage no. 1	14	11	3	78.5
Footage no. 2	14	11	3	78.5
Footage no. 3	13	10	3	77
Net Accuracy		78.04		

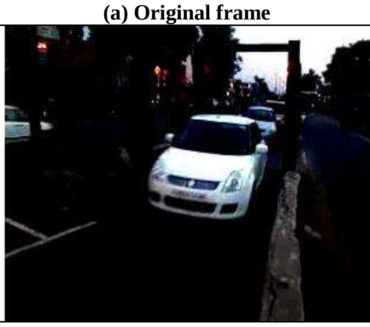
(a) Original frame

(a) Original frame

(a) Original frame

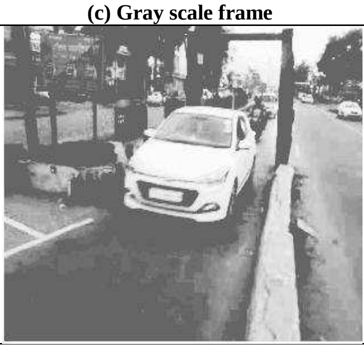
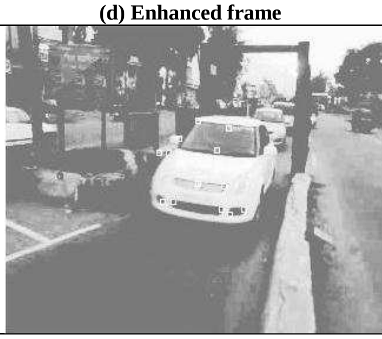
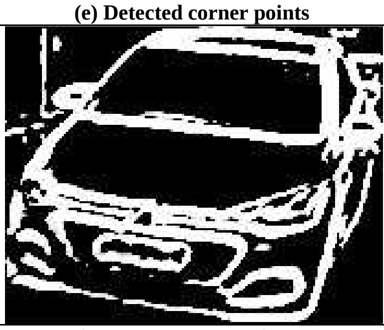
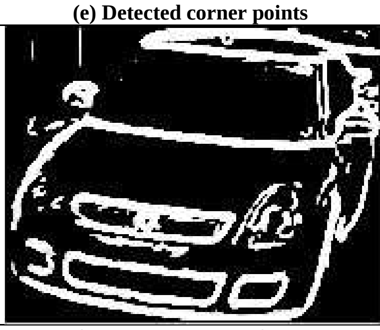
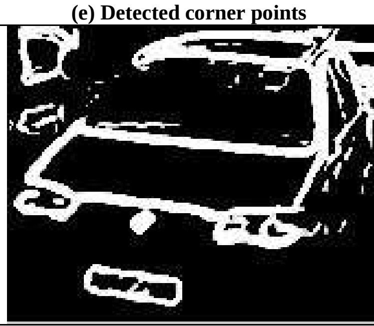
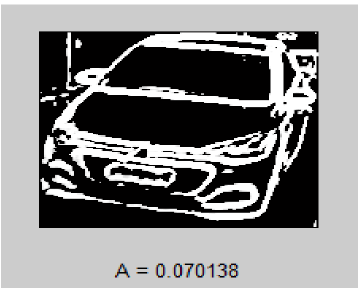
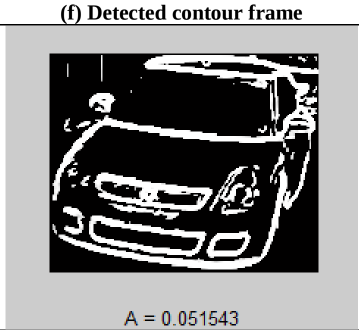
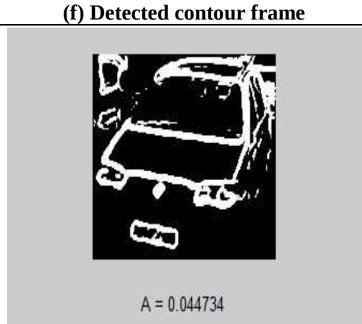


(b) Contrast enhanced frame



(b) Contrast enhanced frame

(b) Contrast enhanced frame

		
(c) Gray scale frame	**(c) Gray scale frame**	**(c) Gray scale frame**
		
(d) Enhanced frame	**(d) Enhanced frame**	**(d) Enhanced frame**
		
(e) Detected corner points	**(e) Detected corner points**	**(e) Detected corner points**
		
(f) Detected contour frame	**(f) Detected contour frame**	**(f) Detected contour frame**
		
(g) Zernike moment value	**(g) Zernike moment value**	**(g) Zernike moment value**
Fig. 3 Results for first vehicle	**Fig. 4 Results for second vehicle**	**Fig. 5 Results for third vehicle**

As seen from Fig. 3 that the proposed algorithm detected RGB values are R=252, G=255, B=255 for unknown vehicle no.1 & detected 13 corner points and also the Zernike movement calculated was = 0.0701(approx.).When the above features were provided to the FIS, the resultant inference from it was that unknown vehicle is the White Hyundai i20 car.

As seen from Fig. 4 that the proposed algorithm detected RGB values are R=251, G=253, B=254 for unknown vehicle no.2 & detected 12 corner points and also the Zernike movement calculated was = 0.0515(approx.). When the above features were provided to the FIS, the resultant inference from it was that unknown vehicle is the White Suzuki Swift car.

As seen from Fig. 5 that the proposed algorithm detected RGB values are R=206, G=219, B=246 for unknown vehicle no.3 & detected 12 corner points and also the Zernike movement calculated was = 0.0447(approx.). When the above features were provided to the FIS, the resultant inference from it was that unknown vehicle is the light steel blue Suzuki Alto car.

Similarly the algorithm was tested for a total of 41 vehicles obtained through three video footages of the same kind. The results of the FIS using the proposed algorithm are tabulated in Table -3. It is observed from the table that for a total of 41 vehicles in the low vision video, the accuracy of classification by the proposed algorithm among six different classes of cars comes out to be 78.04 %. Some results do not match, since factors like shadow from the head lights of detected vehicles or from the nearby passing other vehicles, in the night scene were an influential factors which need to be further manipulated.

CONCLUSION

In the above presented research work, it was perceived that Cars were detected & recognized based on color, corner points & Shape features extracted from the low vision frames of input video. This method can detect and recognize Suzuki Alto, Hyundai i20, Suzuki Swift, Tata Indica, Maruti 800 and Toyota Innova. The input to the FIS was the features extracted from an unknown car i.e. Color of the vehicle, corner points of the Vehicle, and the shape of the vehicle. Based upon the rule list formed earlier, the classified results were obtained from FIS. This method showed an accuracy of about 80 percent In future, more features can be added to improve the classification accuracy, especially for the cases which are affected by strong head lights of vehicles in a night scene.

REFERENCES

[1] M Chaple and SS Paygude, Vehicle Detection and Tracking from Video frame Sequence, *International Journal of Scientific & Engineering Research*, **2013**, 4(3), 1-7.
[2] G Murugesan, SK Vasudevan, S Ramachandran, S Vasudevan and B Arumugam, Vehicle Identification using Fuzzy Adaline Neural Network, *Science Publications*, **2013**, 9(6), 757-762.
[3] P Gupta and GN Purohit, Vehicle Color Recognition System using CCTV Cameras, *International Journal of Advanced Research in Computer Science and Software Engineering*, **2014**, 4(1), 383-389.
[4] RA Hadi, G Sulong and LE George, Vehicle Detection and Tracking Techniques: A Concise Review, *International Journal (SIPIJ)*, **2014**, 5(1), 1-10.
[5] CD Ruberto, AG Dempster, S Khan and B Jarra, Segmentation of Blood Images using Morphological Operators, *IEEE International Conference on Pattern Recognition, Barcelona, Spain*, **2000**, 397-400.
[6] Rafael C Gonzalez, Richard E Woods and Steven L Eddins, *Digital Image Processing*, Tata McGraw Hill Education Pvt Ltd, **2010.**
[7] Konstantinos G Derpanis, *The Harris Corner Detector*, **2004**, 1-2.
[8] DK Jain, G Saxena and VKSingh, Image Mosaicing using Corner Techniques, *IEEE International Conference on Communication Systems and Network Technologies (CSNT)*, **2012**, 79-84.
[9] A Khotanzad and YH Hong, Invariant Image Recognition by Zernike Moments, *IEEE Trans on PAMI*, **1990**, 12, 489–498.