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Real Time License Plate Recognition via Watershed and Viterbi Algorithm

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ABSTRACT

License Plate Recognition (LPR) is the extraction of vehicle license plate information from still images or frame sequences (videos). Character segmentation & recognition has long been a critical area of the OCR process. The characters are detected in the order defined by the matching quality. In this paper three main procedures watershed, thresholding and hidden markov model based Viterbi algorithm was used to perform license plate segmentation and recognition tasks. The watershed transformation with thresholding algorithm based on the gradient approach gives good results for segmentation of characters. This is mainly designed for Indian Car license plate. The procedure follows a simple and effective way to segment and recognize the characters. This paper also presents extensive experiments using real video sequences to verify the proposed method.

Keywords: License plate recognition (LPR), Watershed algorithm, Thresholding, Hidden markov Viterbi algorithm, Optical Character Recognition (OCR) for cars.

I. INTRODUCTION

Segmentation and recognition are two important tasks in image processing and computer vision. License Plate Recognition (LPR) is an integral part of Intelligent Transportation Systems (ITS). License plates are used for identification of vehicles all over the nations so it is illegal for two vehicles to have the same license number. License plate recognition (LPR) algorithms in images or videos are generally composed of the following three modules: (1) license plate detection, (2) character segmentation, and (3) recognition. The first two steps incorporate image processing techniques on still images or frame sequences (videos), whose evaluation relies on the true recognition rate and the error recognition rate. Among these steps, a very critical step is the license plate segmentation, which directly affects the overall system performance. A broad range of methods for license plate segmentation have been reported in the literature.

Vehicle registration plates are formatted as follows:

- Plates for private car and motorized two-wheeler owners have black lettering on a white background (e.g., CG.18.K.1316).
- Commercial vehicles such as taxis and trucks have a yellow background and black text
- (e.g., **MH.12.CD.2544**).
- Commercial vehicles available on rent for self-drive have yellow lettering on a black background
- (e.g., **KA.03.AB.8192**).
- The President of India and state governors travel in official cars without license plates. Instead they have the Emblem of India in gold embossed on a red plate.

Some Indian number plates are shown below:

Figure 1. Samples of license plates in India

Capturing of fast moving vehicles wants technique to avoid blurring of images. The watershed transformation [1][2][10] performs very accurate segmentation that is helpful in case when objects overlap and their borders are hardly detectable. One of the advantages of the watershed transformation is that it always provides closed contours, which is very useful in image segmentation. Another advantage is that the watershed transformation needs low computation times as compared with other alternate segmentation methods. To create segmentation method most robust Thresholding [3][11] method is used with watershed transform in this paper. A global thresholding scheme uses a single threshold to segment the entire input image, whereas a local method computes a threshold value for each individual pixel or local group of pixels. By adapting the Viterbi algorithm with sequencing constraints, the foremost seemingly licence plate symbol sequences were calculated, along with a confidence measure. Generally, a license plate recognition (LPR) system is formed from five parts; Image acquisition, pre-processing of image, plate extraction, character segmentation and character recognition

The remainder of the paper is organized as follows. Section II describes the literature survey. Section III demonstrates Brief Methodology. Experimental results and discussions area unit are given in Sect. IV. In Sect. V, we conclude the paper with future work. References are given in section VII.

II. METHODS AND MATERIAL

1. Literature survey

This section gives an overview of the techniques employed to design the algorithms of vehicle license plate detection, segmentation and recognition. The main challenge is to design a system as versatile as possible to handle the unknown text layout in the image, character fonts and sizes and variability in imaging conditions with uneven lighting, reflection, shadowing and aliasing. Variation in Font style, size, Orientation, alignment & complexity of background even makes the character segmentation as a challenging task in extraction. All these challenges have been considered before developing a good character recognition system.

For license plate location different approaches like edge statics and morphology, sobel filter, hough transform, gabor filter, adaptive boosting with haar-like features, gradient analysis, histogram of oriented gradients HOG, vector quantization (VQ), boundary and edge detection, color and fuzzy aggregation, wavelet transform, discrete fourier transform (DFT) , sliding concentric windows (SCW) etc methods are being used.

For license plate segmentation different approaches like region growing [24], vertical and horizontal projections, connected component analysis, blob colouring, scan line and vertical projection, mathematical morphology and adaptive segmentation, peak-valley analysis, Thresholding[3][11], etc methods are used and shows segmented characters.

The extracted characters are then recognized and the output is license plate. Character recognition methods like template matching on hamming distance, two layer probabilistic neural network, template matching and normalized cross correlation, hotelling transform and euclidean distance, improved back propagation neural network and prior knowledge of the plate layout. After feature extraction many classifiers can be used to recognize characters like hidden markov model, K-nearest neighbor (KNN), Support vector machine (SVM) [19] etc.

Some researchers also used combined features and parallel methods [1] for LPR system whereas some also used joint segmentation [15] and recognition for their algorithms. We could not find much work in progress at real time using robust and effective classifier on number plate segmentation and recognition for better performance.

2. Proposed Algorithm

In this section we discuss about our proposed system. Figure: 2 shows the algorithm of license plate detection and recognition system used in this paper. This mainly consist of three main modules: License plate detection, segmentation and recognition.

A. Processing of Video Signal and Image Acquisition

The initial phase is to take videos from optical (digital/video) camera, CCTV or webcam etc is given as raw input data in MP4 format. Due to technological advancements image acquisition process can be achieved at low cost. Then the first step is the image acquisition (frame sequence) from video when it runs. Thus the images will be stored as colour JPG format. Then on this image further processing will be done.

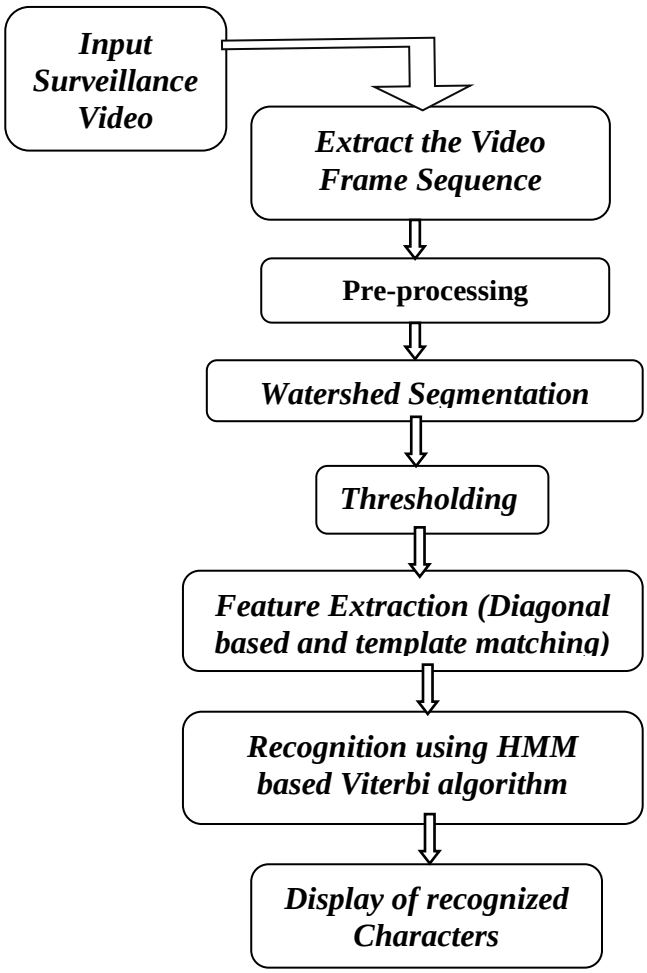


Figure 2. Proposed flowchart for license plate recognition

B. Pre-processing

The aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task. The Stretching is done which makes the brighter appearance of car which helps in more clarity of image captured. This sets the fraction of the image to saturate at low and high pixels and adjust the image intensity with 1.0 or white.

C. Proposed Character Segmentation

Character separating is a procedure in which the number plates' characters are separated. Two methods used here for segmentation of characters are Watershed and Threshold algorithms.

a) Watershed Algorithm:
Two methods of watershed segmentation used here:

1. Distance Transform Approach
2. Gradient method

1) Distance Transform Approach :

A tool used commonly in conjunction with the watershed transform for segmentation is the distance transform (DT). It is the distance from every pixel to the nearest nonzero-valued pixel. A binary image can be converted to a gray level image, which is suitable for watershed segmentation using different DT. City Block DT has a higher possibility of over segmentation for the components in the image. The reason is that City Block DT propagates to the neighborhood in the shape of disk.

2) Gradient Method :

The gradient magnitude is used to preprocess a gray-scale image prior to using the watershed transform for segmentation. The gradient magnitude image has high pixel values along object edges and low pixel values everywhere else. Watershed transform would result in watershed ridge lines along object edges. Another advantage of this method is that it splits the segmentation process into two separate steps: first we detect the main edges of the image processed, and then we compute the watershed of the gradient detected

b) Thresholding Algorithm :

Thresholding is the simplest method of image segmentation. Segmentation involves separating an image into regions (or their contours) corresponding to objects. The simplest property that pixels in a region can share is intensity. So, a natural way to segment such

regions is through thresholding, the separation of light and dark regions. Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one. Mathematically it can be represented as,

$$g(x,y) = \begin{cases} 1 & f(x,y) \geq T \\ 0 & otherwise \end{cases}$$

Where f(x,y) is the original grayscale image, g(x,y) is the threshold output image and T is the threshold value obtained.

D. Feature Extraction

In this stage, the features of the characters that are crucial for classifying them at recognition stage are extracted. In this paper, template matching and diagonal based feature extraction methods are used. Diagonal features are very important features in order to achieve higher recognition accuracy and reducing misclassification. These features are extracted from the pixels of each zone by moving along its diagonals as shown in Fig 2. Following algorithm describes the computation of Diagonal Features for each character image of having 10*10 zones and thus each zone having 10*10 pixel sizes. Each of these zones is having 19 diagonals. The number of foreground pixels along each diagonal are summed up to get 19 features from each zone, then these features for each zone are averaged to extract a single feature from each zone.

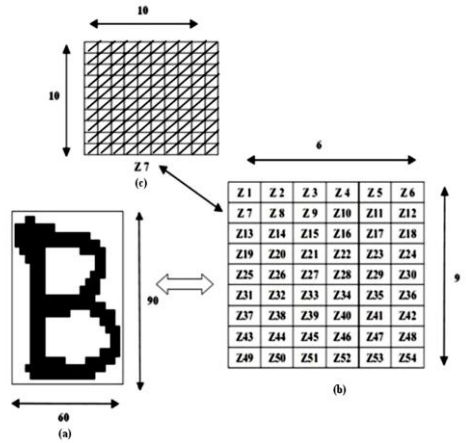


Figure 3. (a) Character Image (b) Image divided into 54 zones (c) Diagonal Feature Extraction in a zone each of size 10*10 pixels.

Template Matching is a high-level machine vision technique that identifies the parts on an image that match a predefined template. Template Matching techniques are expected to address the following need: provided a reference image of an object (the template image: characters image) and an image to be inspected (the input image: car image) we want to identify all input image locations at which the object from the template image is present. Edge based matching is used in this paper.

Edge-based Matching is that the shape of any object is defined mainly by the shape of its edges. Therefore, instead of matching of the whole template, we could extract its edges and match only the nearby pixels, thus avoiding some unnecessary computations. In common applications the achieved speed-up is usually significant.

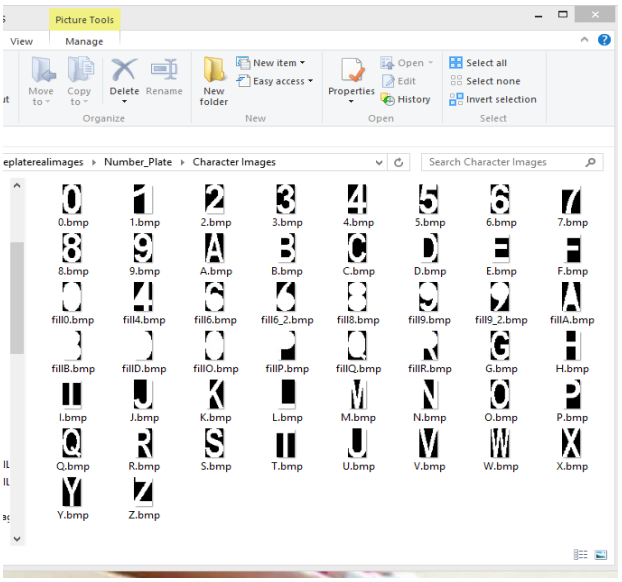


Figure 4. Template image of alphanumeric characters

E. Character Recognition

Lastly the character recognition process will be done to correctly recognize license number plates. Hidden Markov Model (HMM) is a probabilistic pattern matching technique that has ability to absorb both the variability and the similarity between image samples. After feature extraction the viterbi algorithm robustly classifies the license plate characters. The Viterbi algorithm performs Maximum likelihood decoding.

1. It finds a path through the trellis with the largest metric (maximum correlation or minimum distance).

2. It processes the demodulator outputs in an iterative manner.
3. At each step in the trellis, it compares the metric of all paths entering each state, and keeps only the path with the smallest metric, called the survivor, together with its metric.
4. It proceeds in the trellis by eliminating the least likely paths.
5. There will be 3 states in this Viterbi algorithm:

- Start probability (I)
- Transition probability
- Emission probability

Suppose we are given a hidden Markov model (HMM) with state space S, initial probabilities π_i of being in state I and transition probabilities $a_{i,j}$ of transitioning from state I to state j. Say we observe outputs y1,…,yT. The most likely state sequence x1…,xT that produces the observations is given by the recurrence relations equation(1) as :

$$V_{1,k} = P(y_1 \mid k).\pi_k$$
$$V_{t,k} = \max_{x \in s}(P(y_t \mid k).a_{x,k}.V_{t-1,x}) \quad \ldots.(1)$$

Here Vt,k is the probability of the most probable state sequence P(x1,…,xT,y1,…,yT) responsible for the first t observations that have k as its final state. The Viterbi path can be retrieved by saving back pointers that remember which state x was used in the second equation. Let Ptr(k,t) be the function that returns the value of x used to compute Vt,k if t>1, or k if t=1.

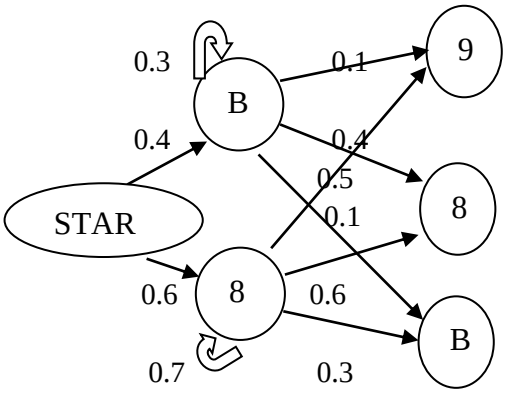


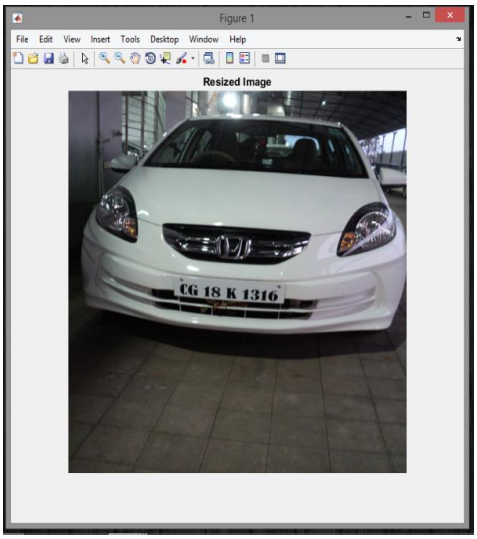
Figure 5. Graphical representation of Viterbi for recognition of character '8'

In above trellis there is confusing characters 8 and B. The emission probability represents how likely the character is in the next stage.

III. RESULTS AND DISCUSSION

Experimental Results

This method has been tested over a large number of real time videos or frame sequences captured from camera in order to analyse its performance. The performance of the test results demonstrate that the proposed method is efficient to be used for the license plate recognition system. The Automatic Vehicle Registration Plate Recognition System was designed using MATLAB 2015(a) for recognizing the number plate. Below figures 6 shows the experiment results done on one real image frame sequence:



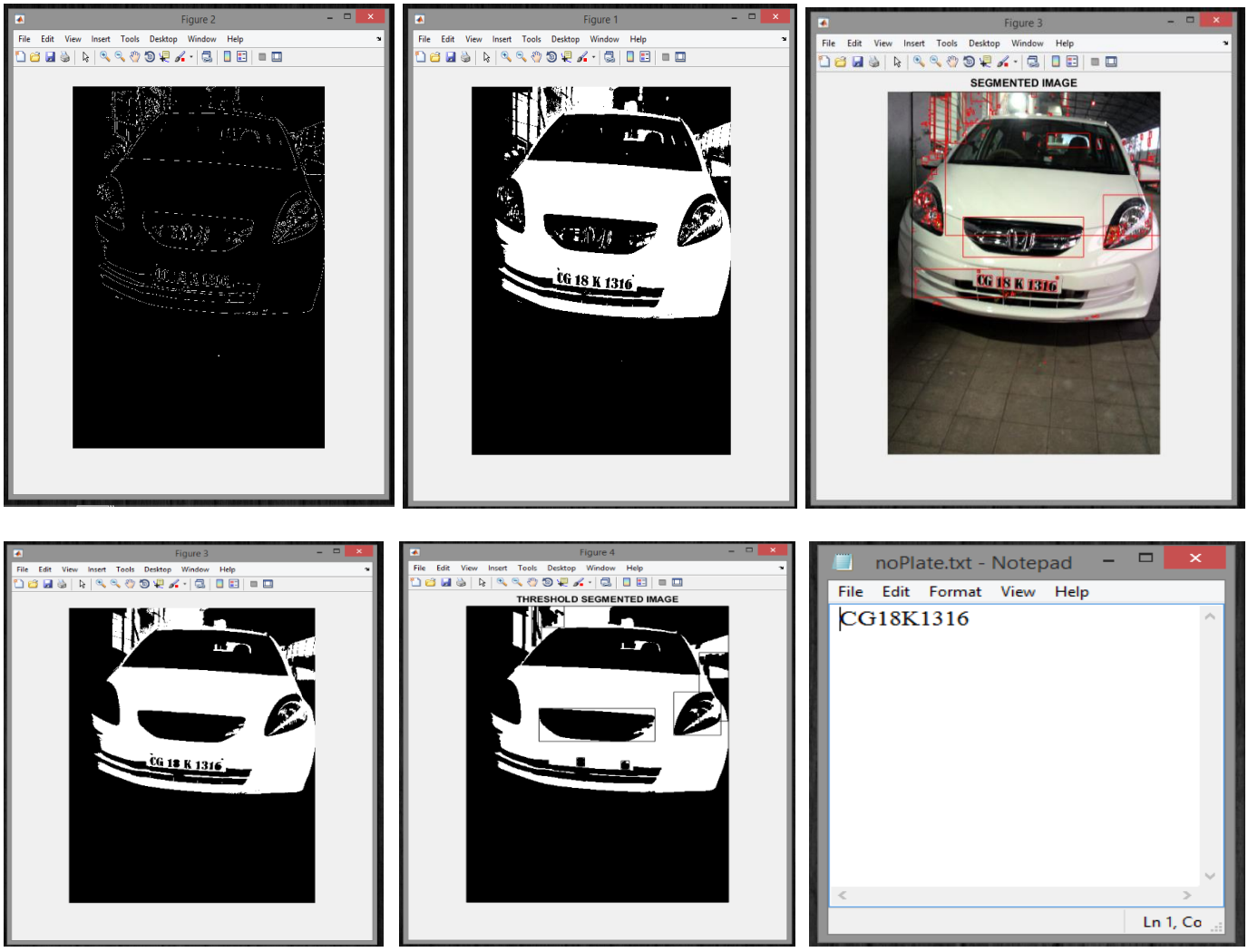


Figure 6. Output images : (a) Original Image (b) Resized Image (c) Stretched Image (d)After applying edge detection (e) Filled Image (f) Segmented LPR characters via watershed (g) and (h) Using gradient threshold (i)Result obtained

PERFORMANCE SUMMARY OF THE PROPOSED SYSTEM

Videos	*Accuracy*	*Sensitivity(TPR)*
VIDEO A	0.8	0.83
VIDEO B	0.7	0.76
VIDEO C	0.5	0.667
VIDEO D	0.6	0.714
VIDEO E	0.9	0.90
VIDEO F	0.5	0.67
VIDEO G	0.9	0.90

IV. CONCLUSION

A simple but efficient license plate extraction method is presented in this paper. The proposed method is basically for real time Indian license plates. We have considered two approaches watershed and thresholding for license plate segmentation and hidden markov based Viterbi algorithm for recognition of license plate. The template matching and diagonal based feature extraction works very well here. Further improvements are possible: 1) to use more advanced classifiers to recognize characters at any weather condition; 2) to recognize slant and rotated location of vehicle number plates. Moreover our experiment that has been carried out, clarifies the proposed system as a potential candidate for real time recognition. The experiment shown in this paper assumed ideal weather condition

V. REFERENCES

[1] Veena M.N, Vasudev T :A Parallel Computing Model for Segmentation of Vehicle Number Plate through Watershed and Visualization Technique. In the International Journal Of Engineering And Science (IJES) Volume 4 Issue 6 Pages PP.63-68 June – 2015 ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

[2] Hongyuan Wang, Chunwan Yuan : License Plate Location Method Based on Integrated Features and Marker-Controlled Watershed algorithm 2010 International Conference on Electrical and Control Engineering

[3] Bahman Rashidi : Implementation of a High Speed Technique for Character Segmentation of License Plate Based on Thresholding Algorithm. November 2012 DOI: 10.5815/ijigsp.2012.12.02.

[4] Khaoula Elagouni, Christophe Garcia, Franck Mamalet, Pascale Sebillot. Text Recognition in Multimedia Documents: A Study of two Neural-based OCRs Using and Avoiding Character Segmentation. International Journal on Document Analysis and Recognition, IJDAR, 2014, 17 (1), pp.19-31.

[5] Gee-Sern Hsu, Jiun-Chang Chen, and Yu-Zu Chung : Application-Oriented License Plate Recognition. In IEEE Transactions on Vehicular technology, vol.62, NO. 2, February 2013.

[6] Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Vassili Loumos, and Eleftherios Kayafas : A License Plate-Recognition Algorithm for Intelligent Transportation System Applications. In IEEE Transactions on Intelligent transportation system vol. 7, no. 3, September 2006.

[7] Yunbo Rao : Automatic vehicle recognition in multiple cameras for video surveillance. In Springer-Verlag Berlin Heidelberg Vis Comput (2015) 31:271–280.

[8] Lucjan Janowski, Piotr Kozłowski, Remigiusz Baran, Piotr Romaniak , Andrzej Glowacz, Tomasz Rusc : Quality assessment for a visual and automatic license plate recognition. In open access at Springer, 30 August 2012.

[9] Shen-Zheng Wang, Student Member, IEEE, and Hsi-Jian Lee : A Cascade Framework for a Real-Time Statistical Plate Recognition System. In IEEE Transactions on Information Forensics & Security Vol.2, No. 2, June 2007.

[10] Amandeep Kaur, Aayushi: Image Segmentation Using Watershed Transform. In International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-4, Issue-1, March 2014

[11] Siti Norul Huda Sheikh Abdullah, Farshid Pirahan Siah: Multi-threshold approach for license plate recognition system. In World Academy of Science, Engineering and Technology International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol: 4, No:12, 2010

[12] J.Pradeep, E. Srinivasan :Diagonal Feature Extraction Based Handwritten Character System Using Neural Network. In International Journal of Computer Applications (0975 – 8887) Volume 8– No.9, October 2010

[13] Ying Wen, Yue Lu, Member, IEEE, Jingqi Yan, Zhenyu Zhou, Karen M. von Deneen, and Pengfei Shi, Senior Member, IEEE An Algorithm for License Plate Recognition Applied to Intelligent Transportation System in IEEE Transactions On Intelligent Transportation Systems, Vol. 12, No. 3, September 2011.

[14] Shan Du, Mahmoud Ibrahim, Mohamed Shehata, Members, IEEE Automatic License Plate Recognition (ALPR): A State-of-the-Art Review IEEE Transactions On Circuits & Systems For Video Technology, Vol. 23, No. 2, February 2013.

[15] Xin Fan, Member, IEEE, and Guoliang Fan, Senior Member, IEEE : Graphical Models for Joint Segmentation and Recognition of License Plate Characters. In IEEE Signal Processing letters, Vol. 16, No. 1, January 2009.

[16] M. S. Sarfraz ,A. Shahzad, Muhammad A. Elahi, M. Fraz, I. Zafar, E. A. Edirisinghe : Real-time automatic license plate recognition for CCTV forensic applications. In Springer-Verlag 2011.

[17] Kumar Parasuraman, Member, IEEE and P.Vasantha Kumar An Efficient Method for Indian Vehicle License Plate Extraction and Character Segmentation. In 2010 IEEE International Conference on Computational Intelligence and Computing Research.

[18] Mr. G. T. Sutar, Prof. Mr. A.V. Shah :Number Plate Recognition Using an Improved Segmentation. In International Journal of Innovative Research in Science, Engineering and Technology Vol. 3, Issue 5, May 2014.

[19] Shriram Kishanrao Waghmare, A. K. Gulve,Vikas N.Nirgude :Automatic number plate recognition (ANPR) system for Indian conditions using support vector machine(SVM). In international journal of computer science & its applications [ISSN 2250 - 3765].

[20] Badr Al-Badr, Robert M. Haralick : A segmentation-free approach to text recognition with application to Arabic text. In IJDAR (1998) 1: 147-166, Springer-Verlag 1998

[21] Jairo Rocha and The0 Pavlidis: Character Recognition Without Segmentation. In IEEE Transactions on pattern analysis & machine intelligence, vol. 17, no. 9, september 1995

[22] Kilian Q.Weinberger, Lawrence K. Saul: Distance Metric Learning for Large Margin Nearest Neighbor Classification. In Journal of Machine Learning Research 10 (2009) 207-244

[23] S.-L. Chang, L.-S. Chen, Y.-C. Chung, and S.-W. Chen, "Automatic license plate recognition," IEEE Trans. Intell. Transp. Syst., vol. 5, no. 1, pp. 42–53, Mar. 2004.

[24] Manuel Vargas, Sergio L. Toral, Federico Barrero, and Francisco Cortés:A License Plate Extraction Algorithm Based on Edge Statistics and Region Growing. In Springer, september2009.