International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue (4) July, Technovision-2014, ISSN 2249–071X

Technovision-2014: 1st International Conference at SITS, Narhe, Pune on April 5-6, 2014

Automatic License Plate Recognition from Still Image

Rutuja Pimpale
Department of Electronics and Telecommunication,
Bharati Vidyapeeth's College of Engg. for Women, Pune-43
Email: rutuja.pimpale@gmail.com

Divya Mahajan
Department of Electronics and Telecommunication,
Bharati Vidyapeeth's College of Engg. for Women, Pune-43
Email: divya.entc@gmail.com

Karishma More
Department of Electronics and Telecommunication,
Bharati Vidyapeeth's College of Engg. for Women, Pune-43
Email: karishmamore904@gmail.com

Prof. V. R. Pawar
Department of Electronics and Telecommunication,
Bharati Vidyapeeth's College of Engg. for Women, Pune-43
Email: pawar_vr123@yahoo.com

***Abstract* – The automatic license plate recognition (ALPR) has become necessary as use of vehicles is rapidly increasing day by day. ALPR plays an important role in many applications such as effective enforcement of traffic rule, security monitoring of roads, checkpoints, car parking etc. number of techniques and algorithms are proposed for ALPR. However, this is challenging task due to the different plate format, different language characters, rotations, different size of plate, backgrounds and different lighting conditions during capturing the image. In proposed algorithm, an input image is preprocessed through many operations such as rgb to gray image conversion, filtering, binarization etc. and segmented. A number plate image captured by digital camera is taken as input image. Wavelet is used for the feature extraction and artificial neural network based classifier is used.**

***Keywords* – Artificial Neural Network, Back Propagation, License Plate, Wavelet.**

I. Introduction

In recent years because of increase in growth of population and human needs vehicles which plays an important role in transportation and control of such a huge traffic has become a very difficult problem in many big cities across different countries. This problem is needed to be solved. Anti-terrorism and public security is increasing worldwide, so in today's society vehicle license plate recognition has become important in today's society and plays key role in intelligent traffic system.

Automatic license plate recognition systems are used for the purpose of effective control of vehicles in societies and mall parking. It is an image processing system which uses image of a vehicle and recognizes the number plate for system purpose. As each vehicle has a unique identification as its license plate the owner can be identified easily if we have license plate number.

And hence, it efficiently in anti-terrorism activities and also helpful for security purposes in malls and societies.

A typical license plate recognition system consists of five major parts as: acquiring image from the imaging system, localization of number plate, segmentation, feature extraction and character recognition. The license plate system should be region specific and it should also recognize the characters accurately. Accuracy plays vital role in license plate recognition.

II. Past Work

Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Ioannis D. Psoroulas, Vassili Loumos and Eleftherios Kayafas[1], proposed the operation of an automated vehicle license plate recognition system was analyzed in this paper in terms of software and hardware aspects. Its operation is divided in two image processing phases: the phase of license plate segmentation and the phase of license plate processing and character recognition. The former has been addressed through the implementation of SCWs method for image segmentation, connected component analysis, and binary measurements. The latter task is addressed again through the implementation of the SCW method for image binarization in conjunction with a PNN for character recognition.

Shyang-Lih Chang, Li-Shien Chen, Yun-Chung Chung, and Sei-Wan Chen, [2]compared to most previous work that in some way restricted their working conditions, the techniques presented in this paper are much less restrictive. The proposed LPR algorithm consists of two modules, one for locating license plates and one for identifying license numbers. Soft computing techniques rooted in fuzzy (for license plate location) and neural (for license number identification) disciplines were introduced to compensate for uncertainties caused by noise, measurement error and imperfect processing.

Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Ioannis D. Psoroulas, Vassili Loumos and Eleftherios Kayafas[3], has attempted to provide a comprehensive survey of research on LPR and also to offer some structural for the methods described in more than 100 papers. The major contribution of this paper has been to provide a brief source of reference for researchers involved in LP detection and recognition. Dhiraj Ahuja and Kuldeepak [4] proposed a system in which an analysis of different license plate & character segmentation is done. License plate recognition algorithms were implemented using wavelets and neural network in MATLAB and results were obtained Using recognition and time required.

International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue (4) July, Technovision-2014, ISSN 2249–071X

In which gives analysis of obtained and conclusion drawn from the results.

III. Proposed System Design

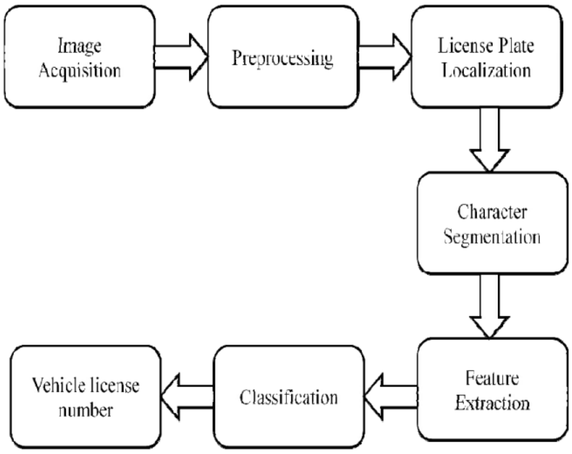

Fig.1. Automatic license plate recognition system flow

Proposed system consists of various fields such as input image, image preprocessing, license plate localization, character segmentation, character recognition etc. as shown in fig 1.

3.1. Image Acquisition

The image acquisition is the first phase license plate recognition process. Image can be acquired either using analog camera with a scanner or by using digital camera. Sometimes image can be acquired from the database downloaded by the internet. Image acquisition through the analog camera is impractical. The reliable and practical approach is acquiring image through the digital camera.

In proposed system, the digital image taken by digital camera is used. Only the picture from front side and back side of the car is included in the database.

3.2. Preprocessing

In order to improve the quality and prepare the picture so that it can be successfully used in next stage, image preprocessing is used before any processing on the image. In image preprocessing many operations are performed on the original image such as rgb to gray scale conversion, filtering, binarization etc.

3.2.1. RGB to Gray Conversion

In gray processing, color image is converted into a gray scale image. For this, different color transform is used. In gray processing, the gray values of pixel is calculated according to the R, G and B value in the image and obtain the gray scale image at the same time. The matlab command rgb2gray converts the RGB value s to grayscale value by forming a weighted sum of the R, G, and B components:

$$I = 0.2989*R + 0.5870*G + 0.1140*B \qquad (1)$$

3.2.2. Median Filtering

To remove noise from the image, filters are used. Lots of noises present in the image during capturing the image. in gray processing, RGB image converted into grayscale image but it cannot eliminate noise which is present in the image. Recognition rate is greatly affected by noise. Hence, removal of noise is necessary step in automatic license plate recognition system. In this system, median filter is used to remove the noise.

A special type low pass filter is a median filter. The median filter takes an area of an image (3x3, 5x5, 7x7, etc.), looks at all the pixel values in that area, and replaces the centre pixel with the median value. The median filter does not require convolution. It does, however, require storing the values in the image area to find the median value. Calculation of filter begins by ordering the N pixels as defined by filter mask from their minimum to maximum values (i.e. ascending order)

$F(0) \le F(1) \le F(2)$………… F(N-1)…..

Where, F(0) is the minimum value and F(N-1) is the maximum value of gray level.

The median value is obtained using,

$$Fmed = \frac{\left[F\left(\frac{N}{2}\right) + F\left(\frac{N}{2}-1\right)\right]}{2} \text{.......if } N \text{ is even} \qquad (2)$$

$$Fmed = F\left[\frac{N-1}{2}\right] \text{........................if } N \text{ is odd} \qquad (3)$$

3.2.3. Binarization

By calculating the level of threshold, this thresholding converts the gray level image into the black and white image. Thresholding has central position in applications of image segmentation because of its intuitive properties, simplicity of implementation and computational speed.

Let u is the original value of the pixel, such as $u \in (0,1)$.

The new value u' is calculated as

$$u = \begin{cases} 0 & \text{If } u \in (0,t) \\ 1 & \text{If } u \in (t,1) \end{cases} \qquad (4)$$

3.3. Segmentation

Character segmentation operation separate out characters and numbers from the license plate. Accuracy of of character recognition significantly. In general, the more accurate the segmentation, the more likely recognition is succeed. But this is one of the most difficult tasks due to the diverse aspect such as different illumination conditions, space between characters noise present in the image, plate frame and rotation of plate.

Connected component analysis, morphological and pattern based segmentation, blob extraction, edge detection, bounding box and Hough transformation these are some of segmentation methods. In proposed system, bounding box segmentation is used. In bounding box segmentation, each individual character is separate out. in such segmentation, row and column indices of plate are

International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue (4) July, Technovision-2014, ISSN 2249–071X

found out using the bounding box and characters are segmented depending on these indices.

3.4. Feature Extraction

Feature extraction is the key process in the license plate recognition system. A feature extraction operation is performed on each segmented character. Good feature extraction increase the accuracy of character recognition and make the character recognition easy. Wavelet transform are used in wide range of image applications. One of the application of the wavelet is feature extraction. Here, wavelet is used for feature extraction. Wavelet has the properties like scalability, seperability, orthogonality, multi-resolution capability and translatability.

We first Scaled and translated basic functions which is used in wavelet transform:

$$\varphi_{j,m,n}(x,y) = 2^{\frac{j}{2}}\varphi(2^j x - m, 2^j y - n) \quad (5)$$

$$\Psi^i{}_{j,m,n}(x,y) = 2^{\frac{j}{2}}\Psi^i(2^j x - m, 2^j y - n), \quad i = \{H,V,D\} (6)$$

where index *i* identifies the directional wavelets.

Rather than an exponent, *I* is a superscript that assumes the values of H(Horizontal details),V(Vertical details) and D(Diagonal details).

The discrete wavelet transform of image *f(x,y)* of size *MxN* is given by,

$$W\varphi(j_0,m,n) = \frac{1}{\sqrt{MN}}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\varphi_{j_0,m,n}(x,y) \quad (7)$$

$$W_\Psi^i(j,m,n) = \frac{1}{\sqrt{MN}}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\Psi^i{}_{j,m,n}(x,y) \quad (8)$$

Where, j_0 is arbitrary starting scale.

$W\varphi(j_0,m,n)$ Coefficients define an approximation of *f(x,y)* at scale j_0.

$W_\Psi^i(j,m,n)$ Coefficient add horizontal, vertical and diagonal details for scales $j \geq j_0$.

We normally let $j_0 = 0$ and select $N = M = 2^J$ so that j = 0, 1, 2,…, J-1 and m = n = 0, 1, 2, …, 2^j - 1.

The digital filters and down sample are used to implement the wavelet transform. The high pass and detail component characterizes the images high frequency information with vertical orientation; the low pass, approximation component contains its low frequency, vertical information both subimages are then filtered column wise and down sampled to yield four quarter-size output sub images: $W\varphi$, W_ψ^H, W_ψ^V and W_ψ^D which are shown in Fig.2.

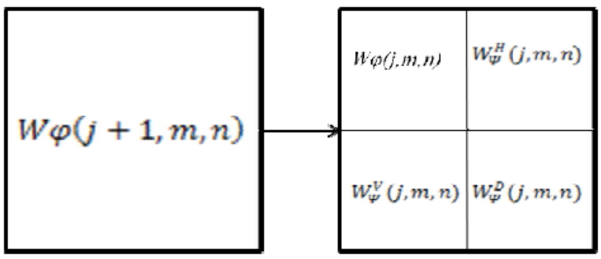

Fig.2. The 2-d fast wavelet transform: the resulting decomposition

3.5. Classification

In character recognition characters are recognized by applying the feature vector to the classifier. This is main part of the system where actual recognition of character is done. For classification and recognition, here backpropagation neural network is used. Backpropagation uses the method, gradient descent to calculate the minimum error function in weight space. The combinations of weights which are used to reduce the error function are used as the solution of the training problem. In back propagation, at each iteration step, it is required to compute the gradient of error function. Following figure shows the general architecture of the backpropagation.

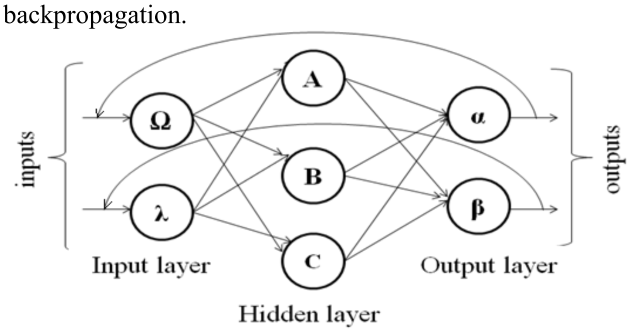

Fig.3. Generic architecture of back propagation

All the calculations for the reverse pass can be calculated as follow:

a. Calculate errors of output neurons

$$\delta_\alpha = out_\alpha(1 - out_\alpha)(Target_\alpha - out_\alpha) \quad (9)$$

$$\delta_\beta = out_\beta(1 - out_\beta)(Target_\beta - out_\beta) \quad (10)$$

b. Change output layer weights

$$W^+_{A\alpha} = W_{A\alpha} + \eta\delta_\alpha out_A \quad (11)$$

$$W^+_{A\beta} = W_{A\beta} + \eta\delta_\beta out_A \quad (12)$$

$$W^+_{B\alpha} = W_{B\alpha} + \eta\delta_\alpha out_B \quad (13)$$

$$W^+_{B\beta} = W_{B\beta} + \eta\delta_\beta out_B \quad (14)$$

$$W^+_{C\alpha} = W_{C\alpha} + \eta\delta_\alpha out_C \quad (15)$$

$$W^+_{C\beta} = W_{C\beta} + \eta\delta_\beta out_C \quad (16)$$

c. Calculate (back-propagate) hidden layer errors

$$\delta_A = out_A(1 - out_A)(\delta_\alpha W_{A\alpha} + \delta_\beta W_{A\beta}) \quad (17)$$

$$\delta_B = out_B(1 - out_B)(\delta_\alpha W_{B\alpha} + \delta_\beta W_{B\beta}) \quad (18)$$

$$\delta_C = out_C(1 - out_C)(\delta_\alpha W_{C\alpha} + \delta_\beta W_{C\beta}) \quad (19)$$

International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue (4) July, Technovision-2014, ISSN 2249–071X

Technovision-2014: 1st International Conference at SITS, Narhe, Pune on April 5-6, 2014

d. Change hidden layer weights

$$W_{\lambda A}^{+} = W_{\lambda A} + \eta \delta_A in_\lambda \quad (20)$$

$$W_{\Omega A}^{+} = W_{\Omega A} + \eta \delta_A in_\Omega \quad (21)$$

$$W_{\lambda B}^{+} = W_{\lambda B} + \eta \delta_B in_\lambda \quad (22)$$

$$W_{\Omega B}^{+} = W_{\Omega B} + \eta \delta_B in_\Omega \quad (23)$$

$$W_{\lambda C}^{+} = W_{\lambda C} + \eta \delta_C in_\lambda \quad (24)$$

$$W_{\Omega C}^{+} = W_{\Omega C} + \eta \delta_C in_\Omega \quad (25)$$

The constant η (called the learning rate, and nominally equal to one) is put in to speed up or slow down the learning if required.

IV. Performance Analysis and Result Analysis

a. Performance Analysis:

Accuracy is calculated by using the confusion matrix. Figure 4 shows the confusion matrix.

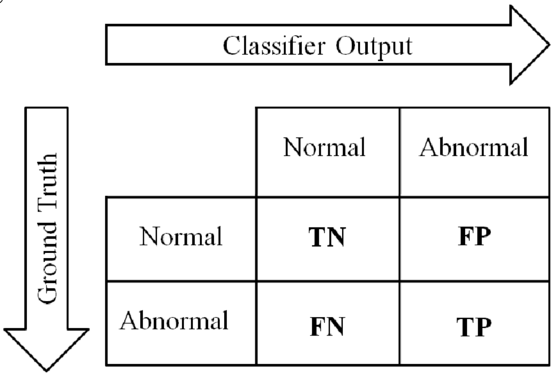

Fig.4. Confusion Matrix
TP – True Positive, TN – True Negative,
FP – False Positive, FN – False Negative.

The confusion matrix is the table where true classification is compared with the output of the classifier. Let us assume that the true classifier is the row and the classifier output is the column. The classification of each sample (specified by a column) is added to the row of the true classification. A perfect classification provides a confusion matrix that has only the diagonal populated. All the other entries are zero.the classification error is the sum of diagonal entries divided by the total number of samples. Percentage average accuracy is the total accuracy of classifier is calculated by

$$\%\,\text{Average Accuracy} = \frac{TP_{(\text{NORMAL})} + TP_{(\text{ABNORMAL})}}{TOTAL_{(\text{NORMAL})} + TOTAL_{(\text{ABNORMAL})}} \quad (26)$$

b. Result Analysis

Figure 5 shows the result of preprocessing module. Figure 5(a) shows the input image of the system which is captured by the digital camera with 14.1 MP which is the RGB image. Figure 5(b) shows the gray image conversion of the input image shown in figure 5(a). Figure 5(c) shows the binary image of the image shown in the figure 5(b) which shows the two level image.

Fig.5. (a) Input Image

Fig.5. (b) RGB to gray conversion

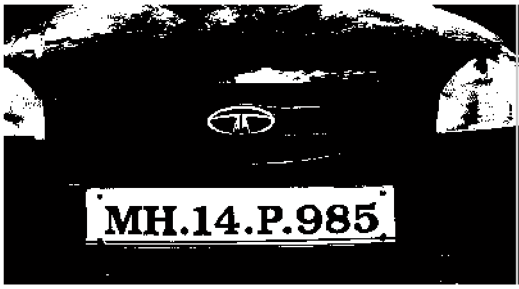

Fig.5. (c) Binary Image
Fig.5. Result of Preprocessing

Figure (6) shows the result of segmented image of the image shown in figure 5(c).

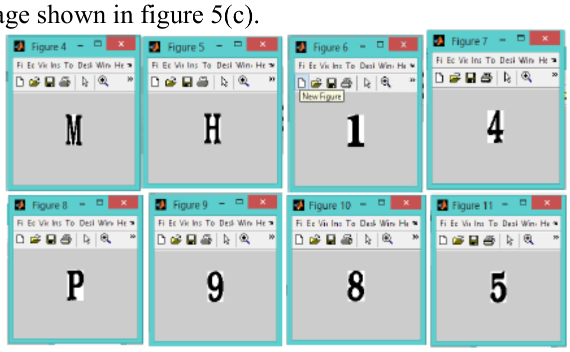

Fig.6. Segmentation of image shown in fig.5(c).

Following figure (7) shows the recognized number plate of image shown in figure 5(a).

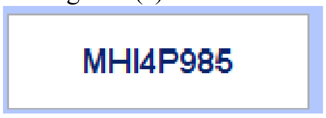

Fig.7. Recognized number *plate.*

Similarly, we have tested 150 other number plates in database.

V. Conclusion

In the proposed system, in preprocessing stage median filter is used which removes the noise better than average filter. Boundary box segmentation gives the more accuracy than connected component analysis, morphological and partition based segmentation. Back propagation classifier gives 90.5% accuracy. Proposed method was applied to a large number of plates near about 150 plates with different angles and distances, different lighting conditions and when the plate is smeared with mud or the characters are damaged. But still there are certain restrictions on parameters like speed of vehicle, script on the number plate, quality of captured image, cleanliness of number plate, skew in the image which can be removed by enhancing the algorithms further.

Acknowledgment

Authors would like to thank Dr. D. S. Bilgi, Principal, Bharati Vidyapeeth's College of Engineering for Women, Pune, Prof. S. T. Khot, Head of E&TC Department, Bharati Vidyapeeth's College of Engineering for Women, Pune.

References

[1] Shyang-Lih Chang, Li-Shien Chen, Yun-Chung Chung, and Sei-Wan Chen, "Automatic License Plate Recognition" , IEEE Transactions On Intelligent Transportation Systems, Vol. 5, No. 1, pp.42-53 March 2004.

[2] Christos Nikolaos E. Anagnostopoulos,Ioannis E. Anagnostopoulos, Vassili Loumos, and Eleftherios Kayafas, "A License Plate-Recognition Algorithm for Intelligent Transportation System Applications", Ieee Transactions On Intelligent Transportation Systems, Vol. 7, No. 3, pp. 377-392 September 2006.

[3] Christos-Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Ioannis D. Psoroulas, Vassili Loumos, and Eleftherios Kayafas, "License Plate Recognition From Still Images and Video Sequences: A Survey" , IEEE Transactions On Intelligent Transportation Systems, Vol. 9, No. 3, pp. 377-391 September 2008.

[4] Dhiraj ahuja and Kuldeepak, " License Plate Recognition Using Wavelets And Neural Networks", Journal of Research in Electrical and Electronics Engineering (ISTP-JREEE), Volume 2, pp.1-5 Issue 1, Jan. 2013