Survey of Number Plate Recognition for Use in Different Countries using an Improved Segmentation

Neha Arora
M-Tech Scholar, Deptt. of Electronics and Communication Engineering
NRI Institute of Information Science and Technology, Bhopal

Suricha Jain[1], Prof. Puran Gour[2]
[1]Asst. Prof., [2]HOD Deptt. of Electronics and Communication Engineering
NRI Institute of Information Science and Technology, Bhopal

ABSTRACT
Automatic Number Plate Recognition (ANPR) is a mass surveillance system that captures the image of vehicles and recognizes their license number. ANPR can be assisted in the revealing of stolen vehicles. The recognition of stolen vehicles can be done in an efficient manner by using the ANPR systems located in the highways. ANPR systems are very useful to the law enforcement agencies as the need for Radio Frequency Identification tags and similar equipments are minimized. Since number plate guidelines are not stringently practiced universally, it often becomes difficult to correctly identify the non-standard number plate characters. In this paper we try to deal with this problem of ANPR by using a pixel based segmentation algorithm of the alphanumeric characters in the license plate.It has considered the Indian number plates, where rear follows the number plate standard. This system consist of few algorithm like "Feature based number plate Localization" for locating the number plate, "Image Scissoring" technique for character segmentation and proposed algorithm for character recognition using Support Vector Machine. System can recognize single or double line number plate.

Keywords
Automatic Number Plate Recognition, Character Segmentation, Character Recognition, Region Growing.

1. INTRODUCTION
A number plate is the unique identification of a vehicle. Automatic Number Plate Recognition (ANPR) is designed to locate and recognize the number plate of a moving vehicle automatically. The Fundamental issues in number plate recognition are high accuracy and high recognition speed. The Automatic number plate recognition (ANPR) is a mass surveillance method that uses optical character recognition on images to read the license plates on vehicles. They will use existing closed-circuit television or road-rule enforcement cameras, or ones exclusively designed for the task. They are used by the various police forces and as a method of electronic toll collection on pay-per-use roads and monitoring traffic activity, such as red light observance in an intersection. ANPR can be used to store the imagery captured by the cameras as well as the text from the license plate, with some configurable to store a snap of the driver. Systems normally use infrared lighting to allow the camera to take the picture at any time of the day. A influential flash is included in at least one version of the intersection monitoring cameras, serving both to enlighten the picture and to make the offender aware of his or her oversight. ANPR technology tends to be region-specific, due to plate variation from place to place.

2. PROBLEM FORMULATION
Since 1960s SVMs have become more and more important in the field of pattern recognition. SVM [14, 15] is forcefully competing with many methods for classification. An SVM is a supervised learning method. SVM takes Statistical Learning Theory (SLT) as its theoretical basis, and the structural risk minimization as its optimal object to realize the best generalization. However, SVM was originally designed for binary classification, and its extension to solve multi-class problems is not straightforward. Two main approaches have been suggested for applying SVMs for multiclass classification [16]. They are "one against all" and "one against one". In each and every approach, the most significant basis has been to reduce the multi-class problem to a set of binary problems to enable the use of basic SVM. The first approach, called 'one against all' (OVA) [16, 17], uses a set of binary classifiers, each trained to separate one class from the rest. For a given input xi, there are k assessment functions. xi is classified to be in the one of k classes that gives the largest decision value. The second approach is called 'one against one' (OVO). In this approach, a series of classifiers are applied to each pair of classes, and only the label of the most commonly computed class is kept for each case. Figure 1 shows our system architecture. First, input image is obtained. Feature point detector based on SURF is then used to obtain a list of interesting local key points on the image. A specialized window scanner is then run through the image, the key points that fall inside the window is then classified by a classifier (SVM) to determine if a particular sub-window is a license plate or not.

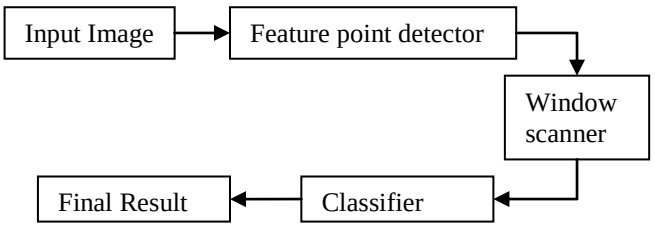

Figure 1: Figure shows our license plate detector system architecture

3. NUMBER PLATE CLASSIFIER
The car number plate at the NSW state of Australia has up to six characters as shown in Figure.1 Usually the number plate consists of two main sections. The upper section contains main information of the number plate, and the lower part is for the name of the state. In order to accelerate the process, we use histogram projection to separate number plate into two groups. The first group usually consists of three or four letters and three or two digits. The second group mainly includes the name of the

state. Therefore, two sets of SVMs are designed according to these two groups of characters. One set of SVMs is designed for recognizing characters of number plates and the other one is designed for characters representing the state. In the experiments shown in [13], it is concluded that 'one against all' (OVA) could obtain higher accuracy than method of 'one against one' (OVO). In order to solve these problems mentioned above, in our SVM-based recognition system, two kinds of SVMs are set up first. Each SVM has one type of number samples as one positive label and all or some of the other samples as another negative label. After training, each SVM gets its own values of parameters. The decision value of the testing sample will be calculated based on the values of parameters obtained. The final recognition result will be achieved according to the class that gives the maximum decision value. We summarize the SVM based algorithm for number plate recognition in this paper as follows. In order to recognize a number plate, we go through the subsequent steps.

Step 1. Pre-process the image of number plate.

Step 2. Segment and normalize the number plate.

Step3. Extract the feature vector of each normalized candidate

Step 4. Train SVMs based on saved sample database.

Step 5. Recognize the number plate by the set of SVMs trained in advance.

Step 6. If there are no more unclassified samples, then STOP. Otherwise, go to Step 5.

Step 7.Add these test samples into their corresponding database for further training.

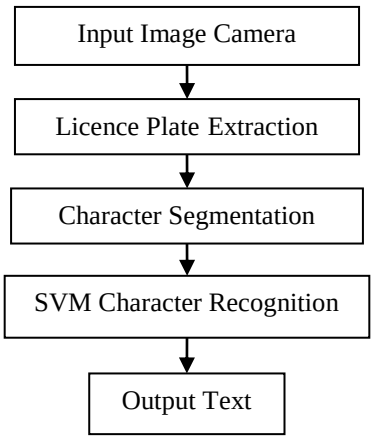

Figure 2: SVM LP Recognition System

4. SVM BASED MULTI-CLASS CLASSIFIER

The SVMs use hyper planes to separate the different classes. Many hyper planes are fitted to separate the classes, but there is only one most favorable separating hyper plane. The optimal one is expected to generalize well in comparison to the others. A new data sample is classified by the SVM according to the decision boundary defined by the hyper plane. Among many classification methods, SVM has demonstrated advanced performance. It has been successfully utilized in handwritten numeral recognition. To train our classifier, an online quasi-Newton stochastic gradient descent algorithm is used [11]. Since SVM is basically an unconstrained empirical loss minimization problem, it can be solved by an iterative algorithm, one like stochastic gradient descent.

A) Format of License plates

Indian number plates could have single row or double row as shown below:

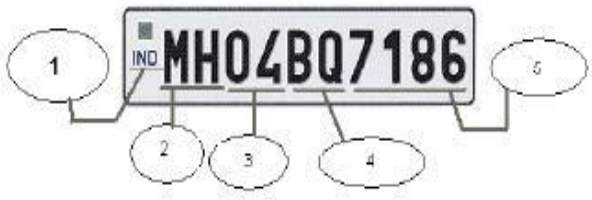

Figure 3: Format of Licence Plate.

The latest License plate format is given above:

1. Country Code.

2. State Code.

3. District Code.

4. Type of Vehicle (Car, Two wheeler, and so on).

5. Actual Registration Number.

B) Number Plate Localization on the Basis of Window Filtering

The drawback of the above solution (Edge Finding Methodology) is that after the filtering also additional areas of high intensity appear besides the number plate. If the image contains a lot of particulars and edges (example: complex background) the further areas. As a consequence, the SFR curve exhibits a smaller increment at the number plate and the edges in the surrounding areas may sometimes be more dominant. The original image with complex Background is Filtered and the filtered image shows the High contrast regions apart from the number plate. The environment is unnecessarily included in the image which made the sight complex. We need to consider a window to exclude the surroundings from the image and concentrate on the genuine image. For this we need to consider an appropriate window size. The window size is predictable on the basis of the expected size of the number plate.

C) Plate Region Extraction

Plate region extraction is the first stage in this algorithm. Picture captured from the camera is first converted to the binary image consisting of only 1's and 0's (only black and white). By thresholding the pixel value of 0 (black) for all pixels in the input image with luminance less than threshold value and 1 (white) for all other pixels. Captured image (original image) and binarized image are shown in Figure 4(a) And 4(b) respectively.

a) Captured region a) Plate Region

Figure 4 a) - Original image, b) - Binarized Image

a) Binarized image b) Image involving only plate

Figure 5 (a) - Plate regions, (b) - Image involving only plate.

The binarized image is then processed using some methods. To find the plate area, firstly smearing algorithm is used. Smearing is a method for the mining of text areas on a varied image. With the smearing algorithm, the image is processed along vertical and horizontal runs (scan-lines). If the quantity of white pixels is less than a desired threshold or greater than any other preferred threshold, white pixels are converted to black. In this scheme, threshold values are selected as 10 and 100 for both horizontal and vertical smearing.

D) Segmentation

In the segmentation of plate characters, license plate is segmented into its ingredient parts obtaining the characters individually. Initially, image is filtered for enhancing the image, and removing the noises and surplus spots. Then dilation operation is apply to the image for separating the characters from each other if the characters are close to each other. After this process, horizontal and vertical smearing is applied for look up the character regions. The consequence of this segmentation is in Figure 6(a).

Figure 6(a): **Locations of plate characters.**

The next step is to cut the plate characters. This is done by finding starting and end points of characters in horizontal direction.

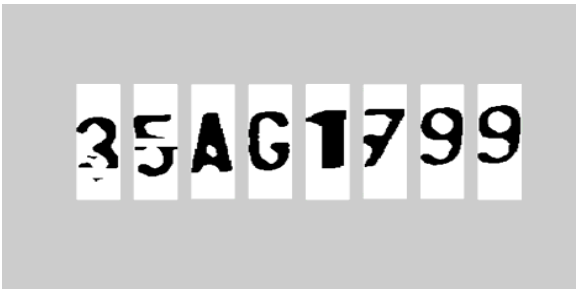

Figure 6(b): Individual characters.

E) Character Recognition

Before recognition algorithm, the characters are normalized. Normalization is to treat the characters into a block containing no extra white spaces (pixels) in all the four sides of the characters. Then each character is well to equal size as shown in Figure 7.

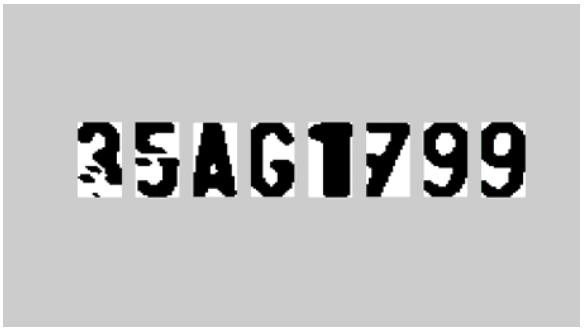

Figure 7: Equal-sized characters

Fitting approach is necessary for pattern matching. For matching the characters with the database, input images should be equal-sized with the database characters. At this juncture the characters are fit to 36 *18. Where the extracted characters cut from plate and the characters on database are now equal-sized. The next step is pattern matching. Template matching is an efficient algorithm for recognition of characters. The character image is compare with the ones in the database and the best similarity is measured. To compute the similarity and find the preeminent match, a statistical method correlation is used. Correlation is an efficient technique for image recognition which was developed by Horowitz. [15] This technique measures the correlation coefficient between a number of known images with the same size unknown images or parts of an image with the highest correlation coefficient between the images producing the exact match. There are two forms of correlations: auto-correlation and cross-correlation. Auto-correlation function (ACF) involves only one signal and provides information about the structure of the signal or its behavior in the time domain. Cross-correlation function (CCF) is a measure of the similarities or shared properties between two signals. Since there are two signals as unidentified input image and known database image in this structure, cross-correlation is used.

F) Recognition Module

A multiple layer perception (MLP) neural network was used in the supervised learning mode. It consisted of 225 input nodes i.e. the 225 pixel values of the working out image, and the output nodes consisted of 36 nodes i.e. the 36 classes (26 uppercase letters and the 10 digits). It was observed that number plates use typically uppercase letters so only uppercase letters were considered. The neural network had only 1 concealed layer with 300 neurons in it. A sigmoid function (explained in the next section) was used as the activation function of the network. This neural network was based on the general gradient-descent technique. A threshold value of confidence was set to pass a glyph as a recognized character or else it is considered as a garbage class. This threshold value is decided after a few trials keeping in mind the allowable tolerance of the Artificial Neural Network (ANN). A database of 50 font samples was used. The system is designed in such a way that the end-user would have the option of rebuilding the database. This feature means the end user can fine-tune the system to meet their specific needs. (E.g. for identifying different fonts used in different geographical regions or countries). The pixel values of the images are passed to the neural network as input. In case of rebuilding the sample font database, the end-user needs to provide image of the sample font (letters and numbers) written in a horizontal or vertical line. (The performance of the system will improve with increase in number of sample fonts. We recommend 50 font samples.) The system will then automatically segment the individual character images,

normalize them to a particular size, arrange the pixels values in a column format and store them in a Microsoft Excel file. The sample data of multiple fonts is thus automatically generated from the provided sample images. This sample data will then be used to retrain the neural network.

5. CONCLUSION

Pre-processing and number plate localization is performed by using Otsu's methods and feature based localization methods respectively. It gives reliability and time optimization. Character reorganization can be performed using the Support Vector Machine. This application is very useful in government as well as big private organizations. But ANPR system still has some restriction such parameter like speed of vehicle, script on the number plate and skew in image this can be removed by enhancing the further algorithms.we presented application software designed for the recognition of car license plate. Firstly we extracted the plate locality, and then we alienated the plate characters individually by segmentation and finally applied template matching with the use of correlation for recognition of plate characters.

6. REFERENCES

[1] D.G. Bailey, D. Irecki, B.K. Lim and L. Yang "Test bed for number plate recognition applications", Proceedings of First IEEE International Workshop on Electronic Design, Test and Applications (DELTA'02), IEEE Computer Society, 2002.

[2] R.A. Lotufo, A.D. Morgan, and AS. Johnson, 1990, "Automatic Number-Plate Recognition," Proceedings of the IEE Colloquium on Image analysis for Transport Applications, V01.035, pp.6/1-6/6, February 16, 1990.

[3] A.S. Johnson, B.M. Bird, 1990, "Number-plate Matching for Automatic Vehicle Identification," IEE Colloquium on Electronic Image and Image Processing in Security and Forensic, April, 1990.

[4] M.M.M. Fahmy, 1994, "Automatic Number-plate Recognition: Neural Network Approach," Proceedings of VNIS'94 Vehicle Navigation and Information System Conference, 3 1 Aug-2 Sept, 1994.

[5] Vehicle Registration Plates of India. Available: http://en.wikipedia.org/wiki/Vehicle_registration_plates_of_India.

[6] Ward Nicholson, "License Plate Fonts of the Western World",Available:http://www.leewardpro.com/articles/licplatefonts /licplate-fonts-intro.html.

[7] Parking and Traffic Technologies Ltd, Smartreg ANPR, Available: http://www.parkingandtraffic.co.uk/ANPR/smartreganpr.

[8] J.A.G. Nijhuis, M.H ter Brugge, and K.A. Helmolt, "Car License Plate recognition with network and fuzzy logic", in Proc. Of IEEE International Conference on Neural Networks., volume 5, pp 2232- 2236, Dec 1995.

[9] Shyang-Lih Chang, Li Shein Chen, Yun-Chung Chung, and Sei- Wan Chen, " Automatic license plate recognition" IEEE Transaction Intelligent Transportation System, 5:42-53,2004.

[10] Ozbay, S., Ercelebi, E., "Automatic Vehicle Identification by Plate Recognition", in Proc of World Academy of Science, Engineering and Technology, Vol-9, November 2005 Available: http://www.oletc.org/ole tctoday/ 0415_licplate.pdf.

[11] Jerome Coninx, License Plate Mania, Available: http://www.licenseplatemania.com.

[12] P. Kulkarni (Student Member, IEEE), A. Khatri, P. Banga, K. Shah "A Feature Based Approach for Localisation of Indian Number Plates", in Proc of International Conference on Electro/Information Technology, IEEE, Windsor Canada, June, 2009.

[13] Genevieve Orr, Nici Schraudolph, and Fred Cummins, "Cs-449 Neural Networks", Willamette University, Available:http://www.willamette.edu/~gorr/classes/cs449/intro.htm l, Fall 1999.

[14] Tran Duc Duan, Tran Le Hong Du, Tran Vinh Phuoc, Nguyen Viet Hoang, "Building an Automatic Vehicle License-Plate Recognition System", in Proc of International Conf on Computer Science, RIVF'05, San Tho, Vietnam, Feb, 2005.

[15] S.Saha, S.Basu, M.Nasipuri, D.K.Basu, "Localization of License Plates from Surveilence Camera Images: A Color Feature Based ANN Approach", in International Journal on Computer Applications, vol-1(23), pp. 25-31, 2010.

[16] S.Saha, S.Basu, M.Nasipuri, D.K.Basu, "License Plate Localization from Vehicle Images: An Edge Based Multi-stage Approach", in International Journal of Recent Trends in Engineering (Computer Science), Vol 1, No. 1, pp. 284-288, May 2009.

7. AUTHOR'S PROFILE

Neha Arora is a research scholar at NRI Institute of Information Science and Technology, under Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal. She is pursuing her Master of Technology in Digital Communication. She has keen interest in artificial intelligence through automated technologies using recognition and segmentation of images.