Vehicle Number Plate Detection and Recognition of Characters by Image Processing

Siddharth Sircar
Department of CSE
Sikkim Manipal Institute of Technology
Sikkim, India

Shivam Alok
Department of CSE
Sikkim Manipal Institute of Technology
Sikkim, India

Pratima Sarkar
Department of CSE
Sikkim Manipal Institute of Technology
Sikkim, India

ABSTRACT
This paper presents the development of a vehicle number plate detection system that is capable of detecting a number plate and extracting the characters from the number plate. The approach is to build a predictive system to predict the position of number plate in an image, and hence, extract the characters from the number plate. The aim here is to predict the position of number plate efficiently in an image and extract characters form the number plate in minimum time.

General Terms
Number plate, processing, detection, extraction, convert, segmentation, histogram, character recognition, MATLAB

Keywords
Image processing, number plate detection, extraction of characters

1. INTRODUCTION
The increase in the number of vehicles on roads is making it difficult to maintain traffic rules and enforce laws for smooth traffic flow. The present Toll-booths and Traffic Management systems which are installed, have a scope of improvement. In order to automate these processes and make them more efficient, a system is required to easily identify a vehicle. The important question here is how to identify a particular vehicle? The answer to this question is by using the vehicle's number plate.

Each country has a unique license number for each vehicle written on its license plate. This number distinguishes one vehicle from another, which is useful and important especially when both cars are of same model and make. An automated system could be implemented to identify the license plate of a vehicle and extract the characters from the region containing a license plate. Such an automated system should be small, and portable.

The number on the plate can be used to get more information about the vehicle and its owner. It can also be used for various applications such as automatic Traffic control, toll tax collection, Border crossings, parking system, Theft of Cars etc.

2. PROBLEM DEFINITION
Some existing number plate detection systems have the following problems:-

2.1 Poor detection of number plate
Some existing algorithms fail to provide efficient results because of use of traditional methods of number plate detection.

2.2 Less Accuracy
Some existing methods of Number plate detection match a default template with different number plates (of different shapes and sizes in India), which gives less accuracy.

2.3 Many characters left unrecognized
In the existing methods, when the characters are not segmented properly then many characters are left unrecognized and the number plate is not properly readable.

3. OBJECTIVES
3.1 The main objective behind the conceptualization of this project is:
To create a program which can detect the number plate from image of vehicle from various distances and extract the number plate effectively.

To extract the characters of the number plate from the image of the number plate with accuracy.

The clarity of extracted number plate should be clearer as compared to extraction through traditional methods.

The accuracy of character recognition should be greater than or equal to 95% with minimum time taken to read the number plate as compared to traditional methods.

4. DESIGN PROCESS
The design of the algorithm follows the below given steps. The successful execution of all steps gives the characters of the number plate in text form.

The steps are capturing input image, extract Y component, noise removal, dilation morphology, vertical edge processing, horizontal edge processing, segmentation, number plate extraction, character extraction, character matching and character display.

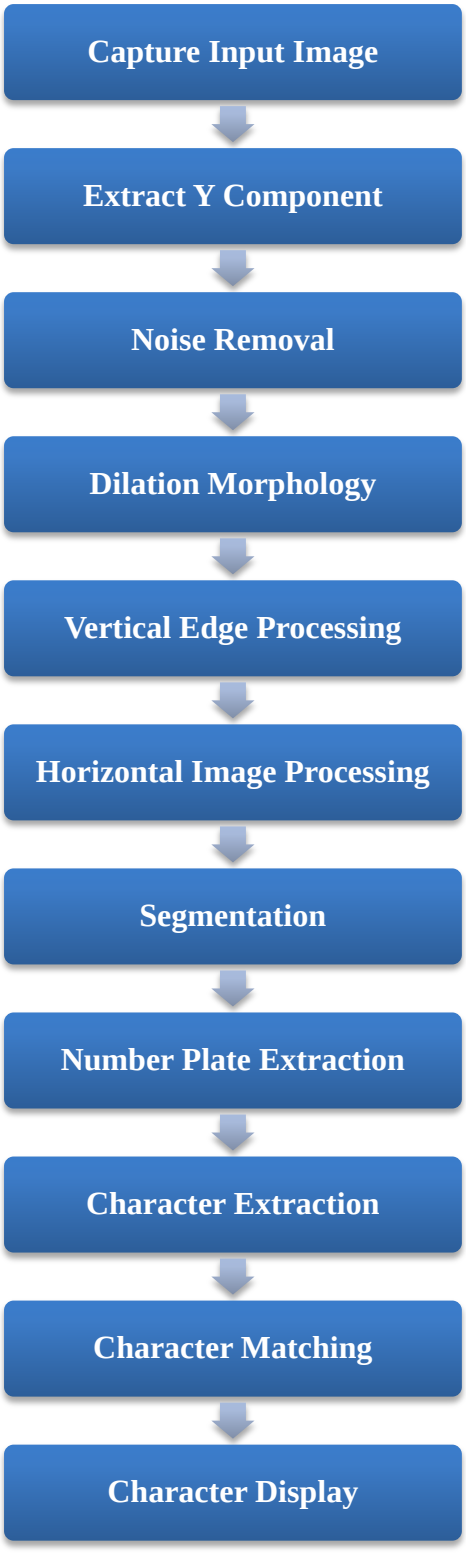

Fig 1. Basic block diagram

5. METHODOLOGY

First, the image is captured through image capturing devices and then fed to the system for conversion of color image into gray scale image. If the image which is fed in the system is a colored image which is represented by 3D array in MATLAB, it is converted to a 2D gray scale image before it is further used for processing. Using dilation, the noise present in the image is removed which sharpens the edges and hence increases the difference of gray value between the neighboring pixels at the edge of an object which will enhance the edge detection. The next step includes detecting rectangular shaped number plate and its extraction using Prediction based algorithm. We partition the number plate into objects/regions for extraction of characters. Finally, the characters of number plate are extracted, matched and displayed.

5.1 Converting a colored image into grey image

The used algorithm uses a grey scale image for processing; hence, the first step is to convert a colored image into a grey image. It is accomplished by a function called rgbtogrey(image). This function converts the colored metal from represented as 3D array to grey image represented as a 2D array.

Fig 2: Conversion from colored image to grey scale image

5.2 Dilation of image

Dilation is a process of improving an image by:-
Filling holes in an image, sharpening of edges of objects in image, joining of broken lines, increasing the brightness of image and removal of noise within image.

Sharpening of edges increases the difference between neighboring pixels, hence increasing edge detection. During converting to grey images the difference in color, lighter edges of objects etc. can get lost. Dilation of image helps in nullifying these losses.

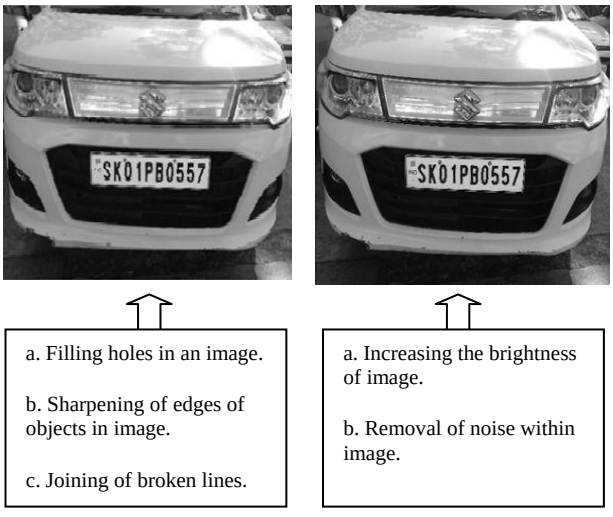

Fig 3: Dilation process

5.3 Horizontal and vertical edge processing

Horizontal and Vertical Edge processing is done, which is represented by column-wise and row-wise histogram respectively. The given histograms basically shows the sum of differences of grey values between neighboring pixels of an image, column and row- wise.

In order to find the horizontal histogram, the algorithm traverses the picture through each of the column. In each column, the second pixel from top gets selected and its difference with the first pixel is calculated. It is added to the total sum of differences of values, if the difference exceeds the defined threshold. Then the difference between the third and second pixel is calculated and so on. This is carried on throughout the image. The same process is carried out vertically for vertical edge processing.

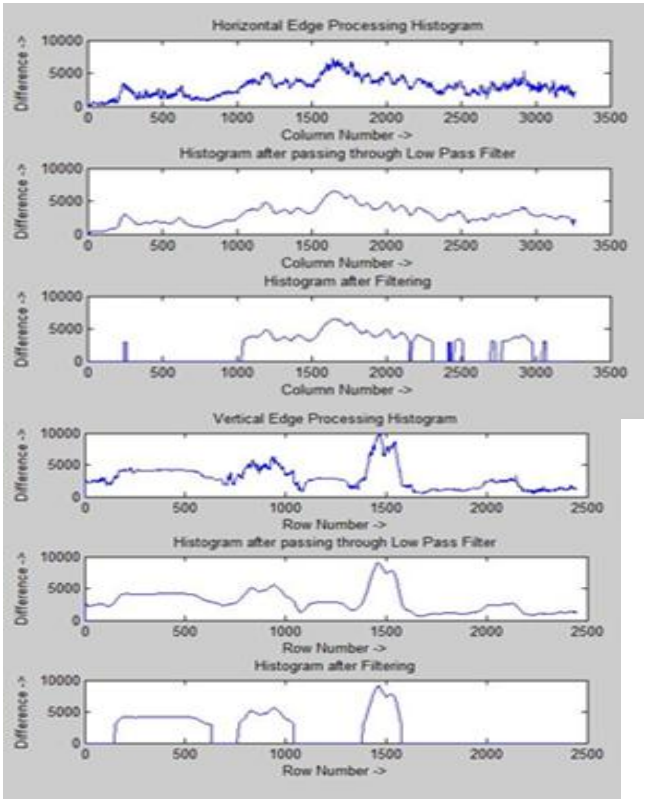

Fig 4: Histograms generated by horizontal and vertical edge processing.

5.4 Passing the histogram through a low pass digital filter

As we see that the histogram values change hugely between consecutive rows and columns. Thus, to eliminate the loss of important information in further steps, it is better to smooth out these changes in values of histogram. So to achieve this purpose, the histogram is passed through a low pass digital filter. The filter averages out each histogram value considering the values on its right-hand side and left-hand side on both horizontal and vertical histograms.

5.5 Filtering out unwanted regions in an image

The unwanted areas from an image is removed using a filter. We consider the unwanted areas as the regions having low histogram values. Removal of such regions is done by applying dynamic threshold. The average value of a histogram is equal to the dynamic threshold. If it has a low histogram value it denotes that the region has very little variation among the neighboring pixels, this helps in ruling out the region to be a number plate. Since a number plate will have big variations in values of histogram because of the presence of a plane background with alphanumeric characters in it, so differences between neighboring pixels will be high. Therefore, a region which will contain probable license plate will have a high horizontal and vertical histogram value and the areas having low histogram values are unwanted and not required.

5.6 Segmentation

All the regions in image having high probability of containing a license plate is found by doing segmentation. In this process the co-ordinates of all such probable regions are taken and is stored in an array. The most probabilistic regions of number plate is shown by output image.

Fig 5: Output of most probable candidates.

5.7 Prediction of region containing number plate/ Extraction of region of interest

From all the regions having the most probability of having the number plate, the one which is having maximum histogram value is considered as the most probable candidate for the number plate detection. To find common maximum horizontal and vertical histogram value containing region all regions are processed row and column wise. That is the region, which is predicted to contain the number plate.

Fig 6: Output of extracted number plate.

5.8 Extraction of characters from extracted number plate

After extraction of number plate, the areas containing alpha numeric characters are recognized and selected in the form of templates. From the database of character templates, the selected areas are matched for character recognition. The characters and numbers which are extracted are stored in the form of string.

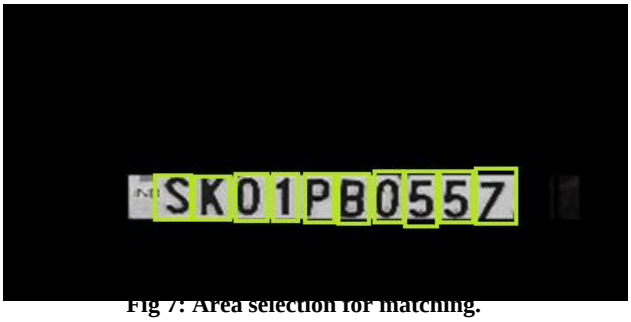

Fig 7: Area selection for matching.

5.9 Character Display

The string containing the characters of the number plate is displayed on the screen.

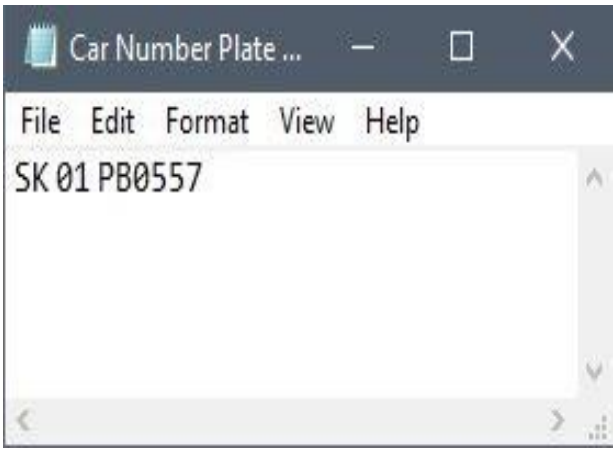

Fig 7: Characters displayed in the form of text.

6. RESULT AND DISCUSSION

Table 1: Reference table for success rate calculation

Attributes	Very Bad	Bad	Good	Very Good	Excellent
Full Number Plate Extraction	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5
Clarity of Number Plate	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5
Clarity of Characters	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5
Detection at various angles	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5
Detection at various distances	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5

Success Rate is calculated by taking percentage by the below formula :-

Success Rate (in %) = (Attribute Value/5)*100

The results are calculated by taking into consideration the size and resolution of the image, the distance from which the image is taken and the time taken for number plate detection and extraction. Then accordingly the success rate is calculated for each and every image by looking up the attributes from the above table.

Table 2: The results calculated for various test cases are given in the following table:

Ref.	Sample Image (resolution)	Distance taken(in meter)	Execution time(in second)	Success Rate(in percent)
1.	carangle.jpg (600x450)	1.25	4.25	85%
2.	carangl1.jpg (600x391)	1.50	3.86	92%
3.	cardist.jpg (1024x576)	2.00	4.45	70%
4.	carback3.jpg (442x333)	5.00	3.34	75%
5.	cardual.jpg (2896x1357)	4.00	16.64	85%
6.	cardist1.jpg (1872x1248)	3.50	10.51	96%
7.	cardist2.jpg (468x294)	5.20	3.14	75%
8.	carfrnt1.jpg (604x483)	1.20	3.94	87%
9.	scooty.jpg (640x480)	4.50	3.79	80%
10.	bike.png (640x426)	1.00	3.60	99%
11.	carnum.jpg (1000x563)	2.70	4.51	85%
12.	carfront2.jpg (640x360)	3.00	3.40	95%
13	carback.jpg (1750x984)	2.40	7.52	75%
14	carback2.jpg (1024x768)	2.00	5.56	90%
15	carfront3.jpg (350x283)	3.50	3.28	99%
16	carbck1.jpg (1200x800)	2.50	6.46	96%
17	cardual.jpg (610x345)	5.50	3.54	95%
18	bike1.jpg (1000x667)	1.00	5.29	96%
19.	cardist3.jpg (600x400)	6.00	3.73	94%
20.	autopic.jpg (467x350)	6.20	5.16	94%

7. SUMMARY AND CONCLUSION

The purpose was to develop an algorithm and thereby a program, which could detect a number plate from an image of a vehicle from various distances, extract the number plate from the image as well as extract characters from the image of the number plate. More emphasis was given on the accuracy of the results. The results were to be precise and the accuracy

needed to be greater than 95% which meant that the identified characters needed to be accurate.

7.1 Prediction based algorithm for number plate detection resulted in:

Removing the drawbacks of the conventional system of template matching which uses Template matching to detect number plate which had a low accuracy.

Fast extraction of number plate as compared to traditional methods.

It is effective in solving problems faced by Police Department, as the GUI of the program is detailed and easy to understand. Even an ordinary person can run the program and get results. In this way, the cost involved in training people to use such software can also be saved.

7.2 Main difficulties encountered and how they were tackled:

The main difficulty was to design the prediction based algorithm in such a way so that it could predict the position of the number plate accurately.

In extraction of characters, the main difficulty was accuracy in character recognition but it was taken care of to make the character recognition as good as possible.

7.3 Limitation of the project:

The program can only give highest accuracy up to 98%.

8. FUTURE SCOPE

This project can extract number plate of vehicle from an image of the vehicle. Since prediction-based extraction works based on prediction of position of number plate in the image there is always some scope of improvement in the accuracy of prediction made by the algorithm.

8.1 We can make improvements in terms of the following parameters given below: -

We can combine both modules for a single point of operation i.e. extracting the number plate and recognizing the characters in the number plate.

We can improve it in terms of time required for extraction to make it faster.

We can improve text recognition in terms of extracting text written in any format. In this way it will help in catching the culprits who misguide security systems by changing the font or format of the number plate of the vehicle. The system can be configured with internet to update the criminal records whenever found, and the same will be updated to all police stations through alerts.

9. ACKNOWLEDGEMENTS

We greatly acknowledge the Sikkim Manipal Institute of Technology for providing opportunity to conduct this project on 'Vehicle Number Plate Detection and Recognition of Characters by Image Processing'. Our sincere thanks to Dr. Kalpana Sharma (Professor and HOD) of Computer Science and Engineering department for motivating us and helping us to carry out this project work.

10. REFERENCES

[1] A. Roy and D.P. Ghoshal, "Number Plate Recognition for use in different countries using an improved segmentation", in 2nd National Conference on Emerging Trends and Applications in Computer Science (NCETACS), 2011.

[2] Fikriye Öztürk and Figens Özen, "A New License Plate Recognition System Based on Probabilistic Neural Networks", Procedia Technology, vol. 1, pp. 124-128, 2012.

[3] H. Erdinc Kocer and K. Kursat Cevik, "Artificial neural networks based vehicle license plate recognition", Procedia Computer Science, vol. 3, pp. 1033-1037, 2011.

[4] Shan. Du, Mohamed. Shehata, Wael. Badawy, "Automatic License Plate Recognition (ALPR): A State-of -the-Art Review", IEEE Vol. 23, No.2, June 2013.

[5] Xiaojun Zhai, Faycal Bensaali, "Standard Definition ANPR System on FPGA and an Approach to Extend it to HD" in IEEE GCC Conference and exhibition, November 17-20, Doha, Qatar, 2013

[6] Bhavin V. Kakani, Divyang Gandhi, Sagar Jani, "Improved OCR based automatic vehicle number plate recognition using features trained neural network", in Computing, Communication and Networking Technologies, in IEEE 8th International Conference on Computing, Communication and Networking Technologies (ICCCNT), Delhi, India, July 2017.

[7] Abhay Singh, Anand Kumar Gupta, Anmol Singh, Anuj Gupta, Sherish Johri, "Vehicle Number Plate Detection Using Image Processing", in International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 03, March 2018.

[8] Balamurugan G, Sakthivel Punniakodi, Rajeswari K, Arulalan V, "Automatic number plate recognition system using super-resolution technique", in IEEE International Conference on Computing and Communications Technologies (ICCCT), Chennai, India, 08 October 2015.

[9] S. Kranthi, K. Pranathi, A. Srisaila, "Automatic Number Plate Recognition", International Journal of Advancements in Technology, Vol 2, No 3, July 2011.

[10] 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", Springer-Verlag, 19 November 2011.