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An Efficient Approach for Number Plate Extraction from Vehicles Image under Image Processing

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***Abstract*— Automatic Number Plate Recognition (ANPR) is an image-processing technology and an important field of research that identifies vehicles by their number plates in which the number plate information is extracted from vehicle's image or from sequence of images without direct human intervention. ANPR consists of 4 phases: - Preprocessing, number plate extraction, character segmentation, character recognition. This paper presents an efficient approach for number plate extraction from preprocessed vehicle input image using morphological operations, thresholding, sobel vertical edge detection and connected component analysis. The input image is firstly preprocessed using iterative bilateral filter and adaptive histogram equalization.**

***Keywords*— Automatic Number Plate Recognition, iterative bilateral filter, adaptive histogram equalization, number plate extraction, morphological operations, thresholding, sobel edge detection, connected component analysis.**

I. INTRODUCTION

In Intelligent Transportation System (ITS) the automatic number plate recognition (ANPR) system plays important role. In current days vehicles play important role in transportation and the use of vehicles is also increasing due to population growth and human needs. Automatic number plate recognition system is used for the effective control of these vehicles. Automatic number plate recognition system is an image processing technology that identifies vehicles by tracking their number plate without direct human intervention. ANPR is also known by various other terms as automatic license plate recognition, automatic license plate reader, number plate tracking, car plate recognition, vehicle number plate recognition, automatic vehicle identification etc.

The attributes of the number plates are maintained strictly in all almost all developed and developing countries. The attributes of number plate are background color of number plate, character color, character size, aspect ratio of number plate; font style, script etc. are maintained strictly. The aspect ratio is very important factor and in all developed and developing country vehicles number plate has same aspect ratio where aspect ratio of a region is calculated as ratio of length to width of that region as

Aspect ratio= Length/Width

In India, two types of number plates are used :- 1) for private vehicles the number plate consist of white background with black letter on it. 2) For commercial vehicles number plate consist of yellow background with black. In India there is no standard followed for the aspect ratio of Indian number plates so the extraction of Indian number plate is difficult compared to the foreign number plate. There are number of applications of automatic number plate recognition system such as automatic toll collection at toll plaza, traffic monitoring and control, border control, stolen vehicle detection, automatic ticketing of vehicles, access control etc. The basic model of automatic number plate recognition system consists of 4 main phases: 1) Image Acquisition and Preprocessing phase 2) Number Plate Extraction 3) Character Segmentation 4) Character Recognition phase. The basic working of ANPR system is shown in Fig. 1. In the first phase image is acquired and some preprocessing operations are performed on it to make better quality input image. In the second phase the exact location of number plate is detected from whole vehicle image and then extracted that portion of image. In the third phase the segmentation of characters from the extracted plate area is done. The last phase is character recognition in which segmented characters are recognized and output is license plate number.

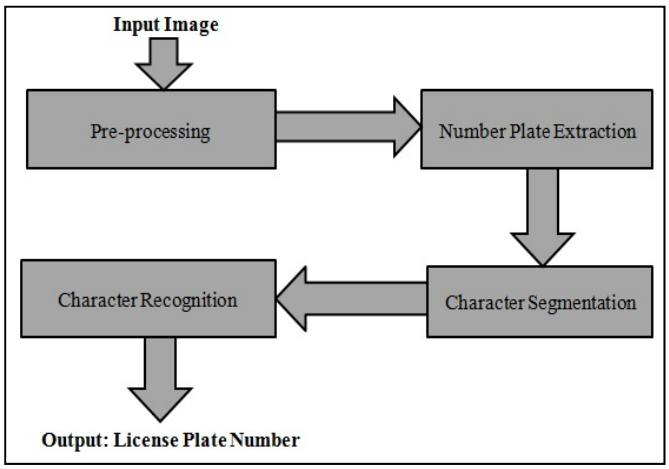

Fig. 1 Basic working of ANPR system

Number plate extraction phase is the most important phase in ANPR system because all others phases depend on exact extraction of number plate area. The extraction of number plate is difficult and directly influences the accuracy of ANPR because all further steps depend on accurate extraction of number plate. Many difficulties occur during the detection and extraction of number plate due to the following reasons:-

1. The efficiency of extraction is affected by scene complexity.
2. Different vehicles have plates located on different position.

3. Noise can occur during camera capture.
4. Weather conditions responsible for noise arrival.
5. Time of day affects lighting thus resulting into contrast problems.
6. Unwanted characters, frames and screws introduce confusion.
7. Wrong camera or plate position result into distortion that affect efficiency of plate extraction.
8. Low or uneven illumination, blurred image, low resolution input image, reflection, shadow affect the efficiency of number plate area extraction.

This paper is organized in V sections. Section II explains literature survey, Section III explain proposed approach for number plate extraction. Experimental result is shown in section IV. Conclusions and future work is given in Section V.

II. LITERATURE SURVEY

Christos-Nikolaos E. Anagnostopoulos [1] presented various methods used for number plate extraction. Shan Du [2] presented a survey on existing ANPR methods and categorizing them according to the features used in each stage and compares them in terms pros, cons, accuracy, and processing speed. Sahil Shaikh [3] proposed method for number plate recognition. For plate localization, several traditional images processing techniques such as image enhancement, edge detection, filtering and component analysis are used. Norizam Sulaiman [4] presented the development of automatic vehicle plate detection system in which after pre-processing the candidate plate is detected by means of feature extraction method, character segmentation is done by boundary box and character recognition is done by template matching. Reza Azad [5] proposed a fast and real time method in which has an appropriate application to find tilt and poor quality plates. In the proposed method, the image is converted into binary mode using adaptive threshold. Ronak P Patel [6] proposed new algorithm for recognition number plate using Thresholding operation, Morphological operation, Edge detection, boundary box analysis for number plate extraction. Najeem Owamoyo [7] proposed Automatic Number recognition for Nigerian vehicles. Number plate extraction is done using Sobel edge detection filter, morphological operations and connected component analysis. Character segmentation is done by connected component and vertical projection analysis. Sourav Roy [8] proposed algorithm for localization of number plate for the vehicles in West Bengal (India) and segmented the numbers as to identify each number separately. This approach is based on morphological operation and sobel edge detection. After reducing noise from the input image the enhancement of image is done using histogram equalization. Divya Gilly [9] proposed an efficient method for LPR. LPR system mainly consists of three main phases 1) plate detection 2) character segmentation 3) character recognition. This method utilizes a template matching technique for character recognition. This method is suitable for both Indian number plates and foreign license plates. Isack Bulugu [10] has proposed an algorithm that is designed to recognize the license plate from the front end and rear end of the vehicle. The implementation of the program is developed on MATLAB (R2010b). Rupali Kate [11] has proposed an algorithm based on morphological operation with number of area criteria tests for number plate localization. Character segmentation was achieved region props toolbox function in MATLAB and character recognition was done by the Template matching. P.Mohan Kumar [12] proposed method for real time vehicle license plate identification. Hadi Sharifi [13] presented the study and evaluation of some important license plate detection algorithms and compared them in terms of performance, accuracy, complexity, and their usefulness in different environmental condition. The dynamic programming algorithm is the fastest and the Gabor transform is the most accuracy algorithm compared to other license plate detection algorithms. Kumar Parasuraman [14] has proposed an algorithm consist of 3 parts. Edge detection algorithm and vertical projection method are used for extracting the Plate region. In segmentation part, filtering and vertical and horizontal projection are used. Chain code concept is used for character recognition. S. Hamidreza Kasaei [15] presented a real time and robust method of license plate detection based on the morphology and template matching.

This paper presents an efficient approach for the extraction of number plate from the vehicle image based on morphological operations (opening, closing, dilation, and erosion), image subtraction, thresholding, sobel edge detection and the connected component analysis. Firstly the input image is preprocessed by iterative bilateral filter and adaptive histogram equalization.

III. PROPOSED APPROACH FOR NUMBER PLATE EXTRACTION

The proposed approach for number plate extraction is represented in this section. Input to this system is vehicle image that is acquired through digital camera and output is the actual number plate portion. Images are acquired in different illumination conditions and in different background. The flowchart of proposed method is shown in Fig. 2 consists of following main steps:

1) Image Acquisition
2) RGB to grayscale conversion
3) Noise removal by Iterative Bilateral Filtering
4) Contrast enhancement by using Adaptive Histogram Equalization
5) Morphological opening and image subtraction operation
6) Image binarization
7) Edge detection by sobel operator
8) Candidate plate area detection by morphological opening and closing operations
9) Actual number plate area extraction
10) Enhancement of Extracted plate region.

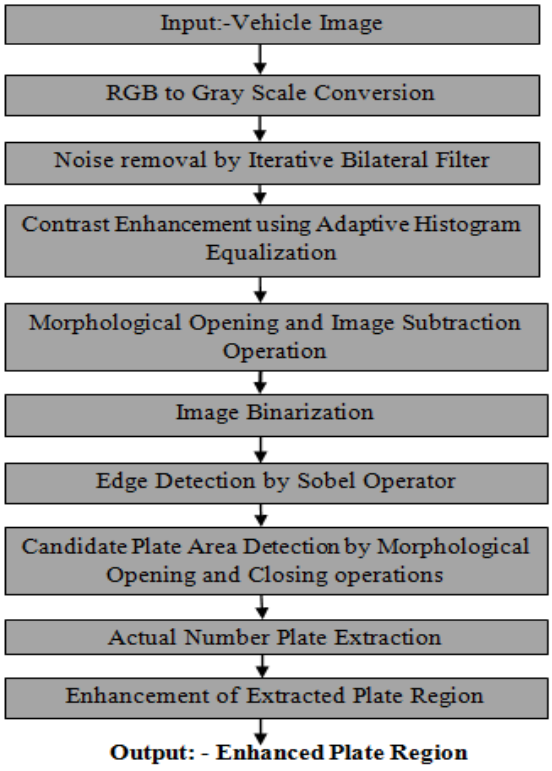

Fig.2 Flowchart of Proposed Approach

A. *Image Acquisition*

The first step is to acquire the input image of vehicle. Image is acquired by digital camera. Images are taken in different illumination conditions and at various distances from the camera. Fig. 3 shows the input vehicle image.

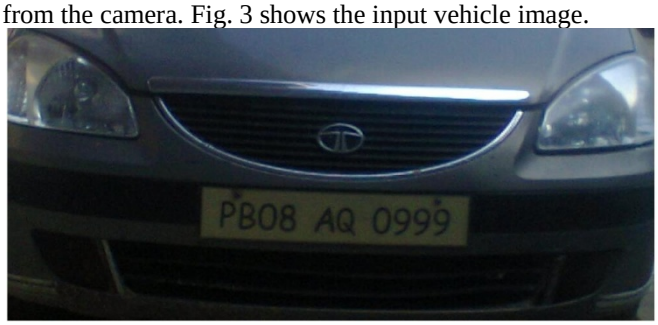

Fig. 3 Input Vehicle Image

B. *Pre-Processing*

In basic aim of pre-processing is to improve the contrast of the input image, to reduce the noise in the image, hence to enhance the processing speed. In pre-processing RGB image is converted into gray level image and then into binary image. The contrast enhancement is done by histogram equalization, contrast stretching etc. Various filters are used to remove noise from the input image. In the proposed approach for number plate extraction, the input image is enhanced by applying adaptive histogram equalization technique and noise is removed by iterative bilateral filtering.

1) *RGB to Gray Scale Conversion:* The captured input image is RGB format. The first step of preprocessing is to convert RGB image into gray-scale image. The basic purpose of applying color conversion is to reduce the number of colors. The R, G and B components are separated from 24-bit color value of each pixel (i, j) and 8-bit gray value is calculated. Fig. 4 shows the gray scale image.

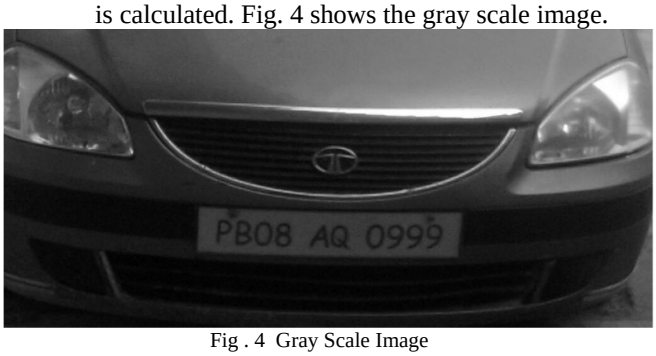

Fig . 4 Gray Scale Image

2) *Noise Removal by Iterative Bilateral Filter:* The basic aim of filtering is to remove noise and distortion from the image. The noise can occur during camera capturing and due to weather conditions. In the proposed method iterative bilateral filter is used for noise removal. Iterative bilateral filter is non-linear filter. It provides the mechanism for noise reduction while preserving edges more effectively than median filter. The result of applying iterative bilateral filter on gray scale image is shown in Fig. 5.

Fig. 5 Result of applying iterative bilateral filter on gray scale image

3) *Contrast Enhancement using Adaptive Histogram Equalization:* Contrast is defined as difference between lowest and highest intensity level. Histogram equalization is a method for spreading the histogram of pixels level more effectively. Adaptive histogram equalization shows better contrast than histogram equalization. Fig. 6 shows contrast enhancement by adaptive histogram equalization.

Fig. 6 Contrast Enhancement using Adaptive Histogram Equalization

C. Morphological Opening and Image Subtraction Operations

Morphological opening operation is performed on the contrast enhanced gray scale image by using disc shaped structuring element. In image subtraction the morphological opened image is subtracted from contrast enhanced gray scale image. Fig. 7 shows the result of opening operation on contrast enhanced gray scale image using disk shaped structuring element and Fig. 8 shows the result of image subtraction between contrast enhanced gray scale image and opened image.

Fig. 7 Opening effect using disk

Fig. 8 Image Subtraction

D. Image Binarization

In this operation the subtracted gray scale image is converted into binary image. Firstly threshold level is calculated by Otsu's method. In MATLAB *graythesh* function is used to find the threshold level of image and then according to the calculated threshold the subtracted gray scale image is converted into black and white image by using function *im2bw*. Fig. 9 shows binarized image.

Fig. 9 Binarized Image

E. Edge Detection by Sobel Operator

Vertical edge is detected by sobel operator and result of applying sobel operator to binarized image is shown in Fig. 10 as follow:-

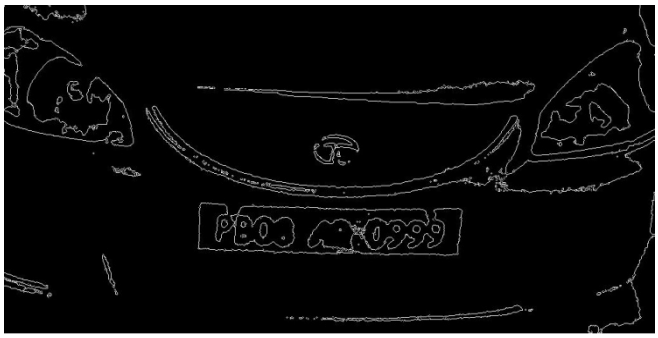

Fig. 10 Edge Detection by Sobel operator

F. Candidate Plate Area detection by Morphological Opening and Closing Operations

With morphological operations the unwanted objects in the image are removed. In detection of candidate plate area, firstly dilation operation is applied on sobel edge detected image and after this holes are filled by using MATLAB *imfill* function. The result of applying dilation operation and filling holes is shown in Fig. 11 and 12 respectively. Then morphological opening and erode operations are used for exact detection of candidate plate area and its result in shown in Fig. 13.

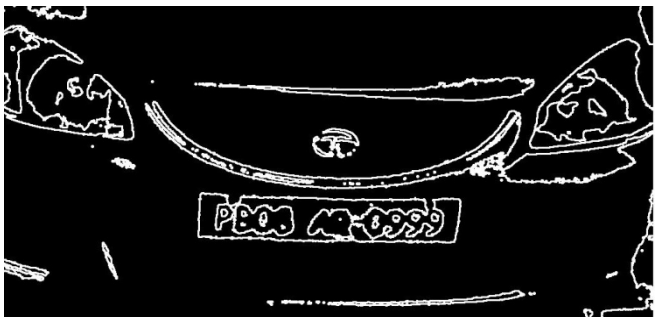

Fig. 11 Morphological Dilation Operation

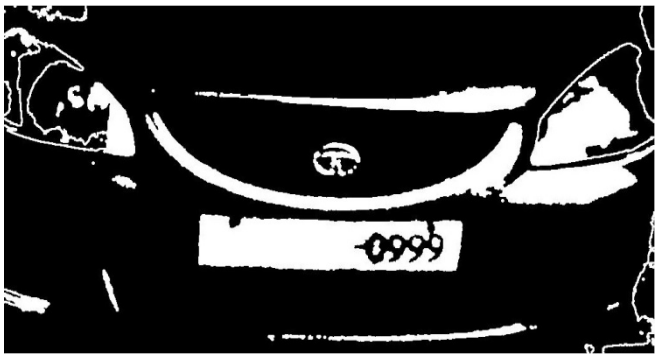

Fig. 12 Image after filling holes

Fig. 13 Number Plate Area Detection

G. *Actual Number Plate Area Extraction*

After the detection of number plate area that area is extracted from the image. Firstly the row and column indices of plate area plate area are found by connected component analysis. Fig. 14 shows the actual number plate extracted area.

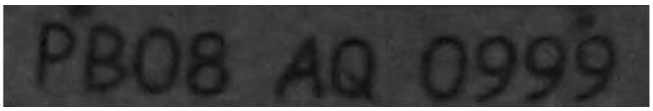

Fig. 14 Extracted True Number Plate

H. *Extracted Plate Region Enhancement*

The extracted number plate may consist of various noise or unwanted holes. So enhancement of plate region is done. Fig. 15 show the result of plate region enhancement by morphological dilation, erosion, opening and closing operation on extracted plate region.

Fig. 15 Enhanced Plate Region

IV. EXPERIMENT RESULTS

This proposed approach for number plate extraction work well for all types of all types of input images (jpeg, png, tiff, jpg, tif, bmp etc). Total 70 vehicle's images are tested. Images are taken in different illumination conditions. The images are taken at different distances relative to camera and are of different colors and different sizes images. The proposed method works well for low contrast, noisy and low resolution input images. The result of proposed approach for number plate extraction is shown in TABLE 1. This method is implemented in MATLAB 7.8.0.

TABLE 1: Result of Proposed Number Plate Extraction Approach

Total Vehicles Images	Successfully Extracted Number Plates	Success Rate (%)
120	118	118/120=98.33%

V. CONCLUSION AND FUTURE WORK

An efficient approach for number plate extraction is presented in this paper. The proposed method is mainly designed for real-time Indian vehicles number plate but it also works well for foreign number plates. This extraction process works well for low resolution, noisy and low contrast images. This method is tested number of vehicles images under different weather and illumination conditions i.e. daytime, night time, sunny, cloudy, rainy days etc and success rate achieved by using this method is 97.14%. In future the extraction of multi-plates, high definition plate processing, multi-style plates can be done.

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