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Article in *International Journal of Computer Applications* · September 2015

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Survey on Automatic Number Plate Recognition (ANR)

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ABSTRACT

Day by day we have been heard about the news of vehicle getting stolen from parking or from any other place in the city. So, to keep track of that stolen vehicle we should have to install the CCTV camera on every signal in the city. Also we have to install the number plate detection system which can detect the number plate of every vehicle on the traffic signal. For detecting the number plate from the moving vehicle there are many algorithm has been developed but still this area always remain evolving each every year, In number plate detection system image processing plays an important role, the system consist of basic operations preprocessing, image conversion from RGB to Gray, apply edge detection, apply morphological operators on same image then extract plate region from image and last process the plate region using OCR (optical character recognition).Every algorithm in this category always follows this basic steps, each algorithm has some pros and cons, because same algorithm cannot be useful for different environmental condition. The Algorithm's efficiency is totally depends upon the quality of input image. E.g. resolution of camera, intensity of the image, illumination of image, shadow effect etc. In this paper we are focusing on which are different algorithm has been developed so far to improve the efficiency of the number plate detection system.

General Terms

Template Matching, Neural Network.

Keywords

Edge Detection, Morphological operator, OCR, preprocessing, ANR (Automatic Number plate Recognition system).

1. INTRODUCTION

The ANR (automatic number plate recognition) plays an important role in many systems like traffic monitoring system, Crime detection system, Stolen vehicle detection [1] etc. Thus, ANR is used by city traffic department to monitor the traffic as well as to track the stolen vehicle. Though ANR is a very old research area in image processing but still it is s evolving year by year, because

Detecting the number plate from the image or from video is not that easy task as like counting the vehicle from stream of video. So far many of the researchers came with their own algorithm to detect the number plate, but each has some limitations. For some images it works perfectly, and for some images it is not working properly. That's the reason this area is still growing and still imperfect. Detecting the number plate is the challenging task as the number plate writing style is changes from country to country. In case of India the number plate writing style changes from state to state. In India the number plate is different for two wheelers and four wheelers. For four wheelers the number plate's background is also different i.e. yellow for tourist and white for private car. These are the basic challenges keep in mind before implementing the ANR system.

ANR has predefined four basic steps to recognize the number plate as explained in the various research paper and journal paper.

1. *Image Capture*: In this steps vehicle Image has to be captured by any standard camera or by extracting the interested frame from stream of video from CCTV live footage. Capturing the image from video stream and CCTV requires an additional work.
2. *Image Preprocessing*: Once the interested image is being captured in which number plate clearly visible and fine texture pattern, then the further processing of the image is carried out. It has many steps: resize the image resolution, removal of noise from image, and conversion of the image from RGB to gray and then Binary (black and white).
3. *Region of Interest (ROI)*: After preprocessing the number plate region from the image is extracted.
4. *Optical character recognition (OCR)*: Electronic conversion of handwritten or printed text images into machine-encoded text. Here *OCR* used to recognize the number from the *ROI* image.

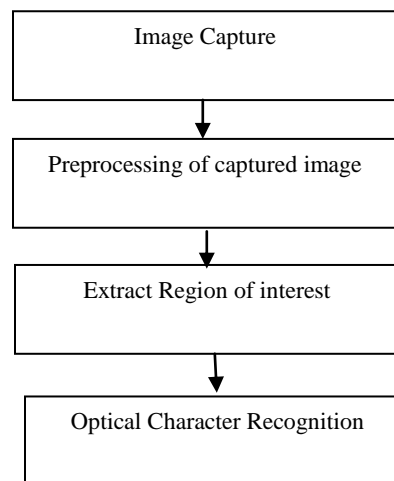


Fig 1: Block Diagram of ANR System

2. RELATED WORK

Every year many researchers came with new and better algorithm for ANR. Some ANR systems are based on hardware and software as proposed by Muhammad Tahir and Muhammad Asif [2]. They have proposed the hardware and software implementation for ANR. They have used one separate hardware device for capturing the vehicle images. And also software code to extract the number from the image, the reason of doing this is to device dependent images.

Another work related to ANR is developing the ANR system for android phone or device [3]. In android phone the

efficiency of their algorithm is 90.86% [3]. As android device CPU has less number of CPU cycles than desktop CPU. The concept of [2], [3] paper are nearly same, in [2] they have implemented their own camera but in [3] they have used the in-build camera of the android device.

In case of software, Kim, K. I., Jung, K. and Kim, J. H [4] had proposed the algorithm based on color image. They have not changed the image from color to gray or binary for number plate extraction.

Segmentation based Number Plate Recognition has given in paper [5]. In [6] authors have used the GA for locating the license plate and selecting the optimum License Plate symbol locations depending on the input geometric relationship matrix (GRM) that defines the geometrical relationships between the symbols in the concerned License plate.

A Hybrid Technique for License Plate Recognition is proposed in paper [7] it is based on Feature Selection of Wavelet Transform and Artificial Neural Network.

In [12] Authors given algorithm for Number Plate Recognition for Indian Cars Using Morphological Dilation and Erosion.

3. BASIC STEPS OF ANR

In this section all the basic steps of ANR and different algorithms used in every step is described.

3.1 Image Preprocessing

Most authors have been proposed different techniques based on image preprocessing, the basic steps are same [5][11] and as follows. Initially image is captured by high quality camera then preprocessing of captured image is performed to reduce the unwanted signals present in the image. In next step the image is converted from RGB to gray scale image based on the threshold value [11].

Image Preprocessing include following steps:

- **Image Conversion**
Converting from RGB to Gray is important step in ANR. Samra and Khalefah have used the standard NTSC method [6][9]. Jitendra Sharma, Amit Mishra and Khushboo Saxena [7] have used the Gaussians filter, wavelet transform and then preserve the high frequency component [7].
- **Binary Processing:**
Next steps is gray to binary conversion Samra and F. Khalefah [6] have suggested the dynamic adaptive threshold method. To avoid the variation in illumination present in the image. The image can be converted to binary there are various methods but Otsu algorithm is faster than sauvola method and niblack algorithm. Both the methods are based on thresholding of the image and provide good result on badly illuminated image [10].
- **Noise Removal:**
After converting to gray scale image some noise still remains in the image. In order to remove the noise from the image different image filter techniques is applied to filter out the noise. One of the best filter, which is widely used in the ANR system is Median filter [5][8][9]. Sarbjit Kaur and Sukhvir Kaur [11] suggested that, Noise also can be removed by using Iterative bilateral filter [11] in ANR Domain. In [19] they have proposed to blur the image in order to remove the noise.

The above steps are not fixed [8]. Author Hanit Karwal, Akshay Girdhar have proposed different steps; first convert

captured image to gray scale, apply median filter to remove the noise, apply otsu method[8][10][11]. Nick, Niblack, Souvola[19] only used otsu algorithms for image binarization. In addition to image preprocessing author sarbjit kaur [11] has implemented new steps in image preprocessing; After converting from RGB to gray the Iterative bilateral filter is applied to remove the noise then contrast enhancement using adaptive histogram equalization [21] followed by opening and image subtraction (contrast enhanced gray image-opened Image) operation.

3.2 Extract Region of Interest (ROI)

In this step the number plate region from the image is being extracted out. There are many ways to extract the region of interest like Bounding rectangle [10], bounding circle and mean shift method [20].

In [12] the authors have used different size of structuring elements for dilation SE (3X3) of rectangle shape, and for erosion SE (10X5). But, in [2][13] the authors have proposed the yellow algorithm to extract the yellow number plate. After extraction they have applied the Smearing algorithm [17] to extract the text area region from the image followed by morphological operations. In [14] the global search algorithm has been used for finding the number plate in an image and extracting only 4 digit from the number plate. In paper [10] they have used the bounding rectangle over license plate. In paper [15] they have used the connected component analysis and features of line segments. In paper [16] authors have used watershed algorithm and color feature through visualization technique to extract the number plate and choose best number plate area. In [8] the ROI has been extracted by using connected component analysis authors have used the 4 connected components, then labeling the connected component for character segmentation. In [9] number plate is detected using edge detection by sobel operator [11][19][21] followed by the Hough transform. And then applied the bounding rectangle to extract the number plate. In [17] authors have used blob detection first and then number plate extraction using smearing followed by Dilation operation and segment of each character in the number plate. In papers [11][18][21] authors have used opening and closing operation to extract the number plate and dilation and erosion to enhanced the extracted number plate. In paper [19] Prewitt, Sobel and modified version of sobel operator is used for Automatic Number Plate Recognition. Canny edge detection algorithm with Logical AND operation gives best result to extract the ROI have been used in [21].

ROI can also be extracted by using advanced algorithm like GA (genetic algorithm) [17]. In [7] they have shown the comparative study of correlation based and neural network. And it is observed that for number plate training and recognition phase the neural network is fast.

3.3 Optical Character Recognition (OCR)

After extracting the number plate area from the image some operation has to be performed to improve the extracted region. Filtering may also be applied to extracted NP (Number Plate) image [21]. Once the number plate region is being enhanced, it is segmented into number plate characters.

Segmentation is the key phase in these domain because the accuracy of the OCR is depends upon how efficiently the character is being segmented. Each character from the Extracted NP is separated out and compared for the available pattern of the same character in the template. There are many methods available to separate out each character. Some of them are static bound, vertical projection, projection of image into X-axis[19] Normalization[7], Watershed transform

algorithm [16], Otsu algorithm [8], Character extraction using column segmentation [2] and connected component technique followed by bounding box [21]. In [7] authors have used the morphological operation for segmenting the characters. Other technique of segmentation is finding the contour that looks like character [19]. In [12] authors proposed the comparative study of the different edge detection algorithm for segmentation like Sobel, Prewitt, Canny, Log based etc. and they observed Canny is the better for them. In many cases adaptive thresholding is used if extracted image has dark foreground with lightweight background with non-uniform illumination.

The segmented character recognized by using template matching [7] and for character recognition Cross correlation method may be used [7][8].

In [20] Number Plate detection and recognition is based on SVM (support Vector Machine). SVM can also be used only for character recognition [21] and GA might also be used to for character recognition [15][6].

OCR can be implemented using **Neural network** as neural network is faster than the template matching used in ANR [22]. In [22][23] authors have suggested that Back propagation algorithm is efficient for extracting the number characters from preprocessed image. In addition to back propagation [23] Anuja has given another approach combination of back propagation and LVQ (Learning Vector Quantization Neural Network) to improve the OCR in ANR.

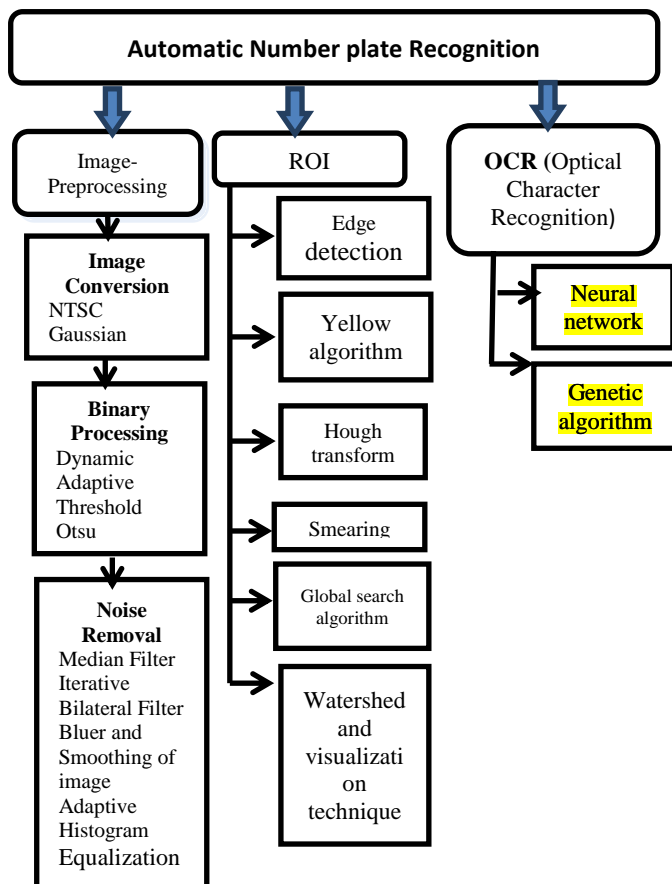


Fig 2: ANR Steps and algorithm used in steps

The Summary of the steps of the ANR and its various algorithms so far used for the number plate recognition are shown in Figure 2.

4. CONCLUSION AND FUTURE SCOPE

This survey is the brief study of algorithms used for ANR (Automatic Number Plate Recognition) and observed the performance of some algorithms. But all these algorithms are image dependent. As image changes the algorithm changes because one's algorithm is efficient for his input image, but inefficient for others input image. So there may be the future work on the algorithm that will be image independent making the algorithms dynamic. During the survey it is observed that Preprocessing plays the major role and extracting the ROI from the image is the difficult and tricky task because the position of the number plate in the image is not fixed for every vehicle image.

5. ACKNOWLEDGMENTS

We offer our gratitude to Department of computer science & Engineering NIT-Silchar and member of Research lab of NIT-Silchar. Which provides us all possible resource for this work.

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