IOSR Journal of Computer Engineering (IOSR-JCE)
ISSN: 2278-0661, ISBN: 2278-8727, PP: 34-39
www.iosrjournals.org

Automatic Number Plate Recognition System: Machine Learning Approach

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ABSTRACT: *In last decade, there has been explosive growth in vehicular sector and the number of vehicles flying on the road in all the parts of the country. For the better management of vehicular traffic, it is necessary to keep track of vehicles on the basis of their number plates. The proposed project suggests an automated way of parking toll collection based on the number plates of the vehicle and the time for which the vehicle is parked in the parking lot. This work deals with the problem from field of artificial intelligence, computer vision (image processing) and neural networks in the construction of an Automatic Number Plate Recognition System (ANPR).This problem includes mathematical principles and algorithms, which ensures a various processes to carry out the steps for the product. The acquisition of the image takes place with any camera with capability of capturing image with good quality. The emphasis of this paper is on the localization of number plate using contours tracing technique along with edge detection and sharpening of edge using Canny's edge detection algorithm. Moreover, we focus on this paper a new algorithm based on artificial neural network (ANN) is used for recognition of number plate characters. This paper makes use of various algorithms in each category from number plate detection to actual recognition of characters which enhances the performance of the system up to the maximum extent possible with less efforts and use of computational resources.*

Keywords: *Artificial Neural Networks, Canny Edge Detection, Character segmentation, Contours, Image Processing Region of interest (ROI)*

I.Introduction

The work being developed is an image processing based work for Automatic Recognition of Number plate from the image of the vehicle taken into consideration which allows one to recognize unique number plate of the vehicle for an intelligent traffic or vehicle management system. With the rapid development of highway and the wide use of vehicle, people have started to pay more and more attention on the advanced, efficient and accurate intelligent transportation systems (ITSs). The automated number plate recognition (ANPR) task is quite challenging from vehicle images due to the view point changes, when vehicle bodies and license plate have similar colour, multi-style plate formats, and the non uniform outdoor illumination conditions during image acquisition[2]. The ANPR is used widely for detecting speeding cars, security control in restricted areas, unattended parking zones, traffic law enforcement, and electronic toll collection, etc. The major steps to accomplish the proposed work can be given as

1. Image acquisition
2. Number plate recognition
3. Edge Detection
4. Character Segmentation
5. Character Recognition and matching with database

The proposed paper is written to deal with the problem in toll collection in the parking lots. The human intervention makes the system very much prone to mistakes and inefficient that's why we propose the system which will automatically capture the vehicle's image and also pre process it by removing the effect of noise and blur with the help of image pre processing activities. This pre-processed image which is the partial output is given to next process i.e. for finding the region of interest which is our number plate. To do that, we are using Contour tracing algorithm. This process will detect the number plate from the image taken. This partially processed image which is the output of the previous step will be given to the next step which is of sharpening of the edges of number plate. This sharpening is done with the help of Canny Edge detection algorithm which along with sharpening of edges also enhances the quality of image using Gaussian kernel as its filtering part. The sharpened image is than inputted to segmentation algorithm which separates out individual characters from

the output of previous step. From that we will find out individual characters that are present in the number plate and we will match them individually with the help of Artificial Neural Networking agents which we be already trained with thousands of sample images. The final output of the system will be the digitalized form of the numbers of the number plate of vehicle. This output along with the time of entry and exit of the vehicle into the parking lot thus calculating the total time the vehicle was in the parking lot and ultimately calculating the toll amount automatically.

The paper is organised as follows: Section II presents the related work on Number plate recognition system. Section III presents proposed methodologies. Finally section IV concludes this paper.

II.Related work

This section includes the work already done on this system by various researchers using different methodologies and algorithms. Following is the brief description of some of them:

Car Plate Recognition Using the Template Matching Method is proposed by M.I.Khalil [1]. Generally, LPR system consists of 4 modules: Image acquisition, licensed plate extraction, segmentation & recognition of individual character. But template matching method does not need the "segmentation" process of input image. After the license plate extraction phase, INFORMATION RECOGNITION PHASE (IPR) is applied. For this phase "moving window technique" is used. To recognize the image the country name, the license plate image is loaded as main image. Then the first image entry of country image set is loaded as an object. The moving window technique is applied to detect that object within the image. If answer is "YES" then the name of country corresponding to country name is retrieved from the country names table. And if answer is "NO" then the next country name image is loaded as the object & this procedure is repeated till the end of the characters**.**

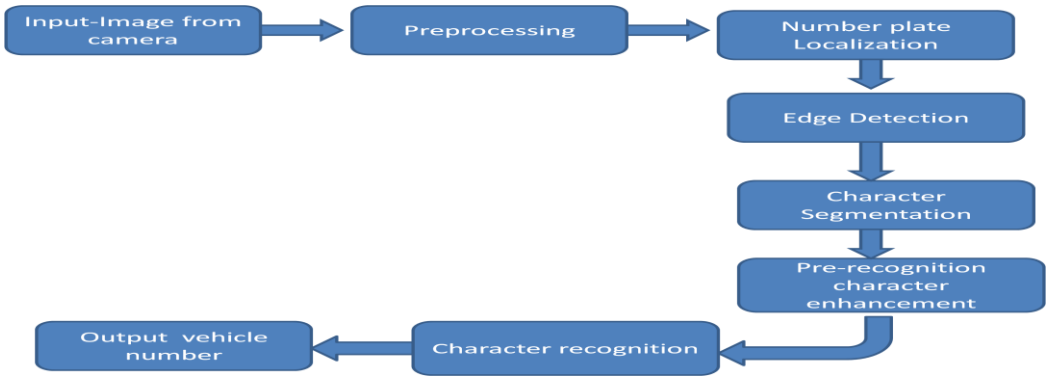
An Efficient Method of Vehicle License Plate Recognition Based on Sliding Concentric Windows and Artificial Neural Network is proposed by Kaushik Deba, Md. Ibrahim Khana, Anik Sahaa, and Kang-Hyun Job [2]. In this system they are using segmentation technique named as sliding concentric windows(scw).this method helps is analyze road images which are often contain vehicles And extract license plate from natural Properties by finding vertical and horizontal edges from vehicle region. On the Basis of a novel adaptive image segmentation technique is for detecting candidate region and Color verification for candidate region by using HSI color model on the basis of using hue and intensity in HSI colour model verifying green and yellow LP and white LP, respectively. Mainly there focus on artificial neural network (AAN) new algorithm which is based on Korean number plate system. If we try to follow they diagram above you will get clear idea about who this system working taking place. How the candidate region selection taking place and how grey image conversion taking in there.

SVM Based License Plate Recognition System is proposed by Kumar Parasuraman [3]. SVM is a supervised learning technique, which takes Statistical Learning Theory (SLT) as its theoretical foundation, and the structural risk minimization as its optimal object to realize the best generalization. Two main approaches have been suggested for applying SVMs for multiclass classification. They are “one against all” and “one against one”. A number plate region is located by using mean shift method and extracted; the histogram projection method in horizontal direction is applied for a simple segmentation only. Then it is normalized into size of 140x36. Then 315 dimensional feature vectors are obtained by averaging values in 4x4 windows of the normalized sub-images. The feature vectors are used to train SVMs with RBF kernel.

From literature survey it has been observed that there are certain limitations about proposed algorithms like:

1. Poor image resolution
2. Less Accuracy
3. Poor lighting and low contrast
4. Higher Computational Cost
5. Lack of standards of the plate of the vehicles
6. Improperly segmented characters will result in misrecognized characters.

III. Proposed Methodology



3.1 Proposed ANPR system

3.1.1 .Image acquisition

The input image for pre-processing is a gray-scale image taken from an Infra-Red (IR) camera.

3.1.2 Image Pre-processing

Pre-processing has to be performed by taking into account the background illumination conditions and the number plate localization algorithms. It is important to eliminate as much background noise as possible, contrast enhancement and de-blurring in the pre-processing step itself to optimize the localization algorithm and also save the processing time. For pre-processing we are going to use some matlab function which will help in pre-processing of the image.

Figure 3.1.2 reduction of noise using image pre-processing

3.1.3 Number Plate Localization

Recognizing the number plate from the image of the vehicle taken in previous step using appropriate algorithm is term as number plate localization or simply finding out ROI i.e. Region of Interest. This step recognizes the location of number plate in captured image so that it will be easier to recognize the number by using only that part of the captured image. The output after localizing the number plate is than inputted to the edge detection algorithm which improvises the edges of characters in the image. By the previous step gives more sharp and clear edges in the image by applying algorithms the edges are classified so that the given set of edges will help to recognize the character.

3.1.3.1 Contour tracing

A contour[7] is an efficient representation of an image since it retains only salient information hence is more valuable for high level computer vision tasks. The design of a detector that can extract all contours from a wide range of images is therefore of interest. Contour tracing is a technique that is applied to digital images in order to extract their boundary. Contour tracing is one of many pre-processing techniques performed on digital images in order to extract information and the location of a particular part of the image about their general shape. Once the contour of a given pattern is extracted, its different characteristics will be examined and used as features which will later on be used in pattern classification. Therefore, correct extraction of the contour will produce more accurate features which will increase the chances of correctly classifying a given pattern or shape.

3.1.3.2 Types of Contour algorithms available

1) Square Tracing Algorithm
2) Moore neighbour tracing algorithm
3) Hole searching algorithm

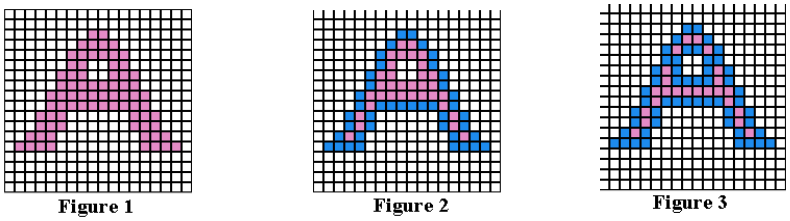


Figure 1 Figure 2 Figure 3

Image before and after applying contour

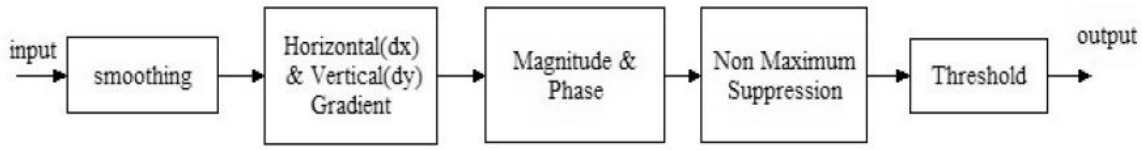
3.1.4 Edge Detection

The process of sharpening and enhancing the edges of an image is termed as edge detection process. From the studied literature is has been found that Canny Edge detection algorithm[4] produces better output than the other edge detection algorithms. The details of Canny Edge detection algorithm are given below:

3.1.4.1 Canny Edge detection algorithm

The Canny edge detection algorithm is considered a standard method because it provides very sharp and thin edges. The Canny Operator works in a multi-stage process. Canny edge detection uses linear filtering With a Gaussian kernel to smooth noise and then computes the edge strength and Direction for each pixel in the smoothed image. This is done by differentiating the image in two orthogonal directions and computing the gradient magnitude as the root sum of squares of the derivatives. The gradient direction is computed using the arctangent of the ratio of the derivatives. Candidate edge pixels are identified as the pixels that survive a thinning process called no maximal suppression. In this process, the edge strength of each candidate edge pixel is set to zero if its edge strength is not larger than the edge strength of the two adjacent pixels in the gradient direction. Thresholding is then done on the thinned edge magnitude image using hysteresis. In hysteresis, two edge strength thresholds are used. All candidate edge pixel values below the lower threshold are labelled as non-edges, and the pixels values above the high threshold are considered as definite edges. All pixels above low threshold that can be connected to any pixel above the high threshold through a chain are labelled as edge pixels.

The schematic of the canny edge detection is shown in figure



3.1.4.1.1 Smoothing

In the first stage the 5x5 Gaussian convolution mask is used for smoothing. The effect of Gaussian convolution is to blur an image. The degree of smoothing is determined by the standard deviation of the Gaussian.

3.1.4.1.2 Gradient Calculation

After smoothing the image and eliminating the noise, the next step is to find the edge Strength by taking the gradient of the image. Most edge-detecting operators can be thought of as gradient-calculators, because the gradient is a continuous-function concept and images are discrete functions, we have to approximate it. Since derivatives are linear and shift-invariant, gradient calculation is most often done using convolution. Numerous kernels have been proposed for finding edges, some of the kernels are: Roberts Kernel, Kirsch Compass Kernel, Prewitt Kernel, Sobel Kernel.

3.1.4.1.3 Magnitude and Phase

Convolution of the image with horizontal and vertical gradients produces horizontal gradient (dx) and vertical gradient (dy) respectively. The absolute gradient magnitude (|G|) is calculated by the mean square root of the horizontal (dx) and vertical (dy) gradients. That is, $2\ 2\ |\ G\ |= dx + dy$. To reduce the computational cost of magnitude, it is often approximated with absolute sum of the horizontal and vertical gradients ($|\ G\ |=|\ dx\ |\ +\ |\ dy|$).The direction of the gradient (q) is calculated by arctangent of the vertical gradient to the horizontal gradient

$q = \arctan(dy/\ dx)$

3.1.4.4 Non-Maximum Suppression

Once the direction of the gradient is known, the values of the pixels found in the Neighbourhood of the pixel under analysis are interpolated. The pixel that has no local maximum gradient magnitude is eliminated. The comparison is made between the actual pixel and its neighbours, along the direction of the gradient. For

example, if the approximate direction of the gradient is between 00 and 450, the magnitude of the gradient at *Pixy* is compared with the magnitude of the gradient at adjacent points.

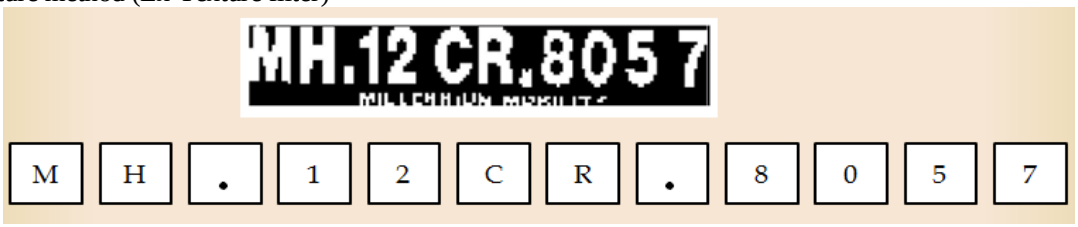
3.1.4.1.5 Threshold

The output image of non-maximum suppression stage may consist of broken edge contours, single edge points which contribute to noise. This can be eliminated by thresholding with *hysteresis*. Two thresholds are considered for hysteresis, one high threshold other low threshold. If any edge response is above a high threshold, those pixels constitute definite edge output of the detector for a particular scale. Individual weak responses usually correspond to noise, but if these points are connected to any of the pixels with high threshold, they are more likely to be actual edges in the image. Such connected pixels are treated as edge pixels if their response is above a low threshold. To get thin edges two thresholds (high threshold (TH) and low threshold (TL)) are used. If the gradient of the edge pixel is above the TH, it is considered as an edge pixel. If the gradient of the edge pixel is below TL then it is unconditionally set to zero. If the gradient is between these two, then it is set to zero unless there is a path from this pixel to a pixel with a gradient above TH; the path must be entirely through pixels with gradients of at least TL.

3.1.5 Segmentation

Character segmentation is the method which separates character present in the image.Methodologies available

1 Transform method (Ex-Watershed)
2 Texture method (Ex-Texture filter)



3.1.6 Recognition of individual character with the help of mapping with database

The characters thus obtained are mapped with the database so as to find licensed user of that number plate and result is displayed. The system will make use of Artificial Neural Network to perform the task of Pattern Matching. These Artificial Neural Networks will be trained on various image samples before final release of the system.

IV. Conclusion

The study of the proposed system done so far provides sufficient data to determine which algorithms are best suited for implementation for each sub part of ANPR system. The predefined functions available for pre-processing in MATLAB are to be used for first two steps of implementation which reduces the computational cost to some extend which is the drawback of above algorithms. The Contour Tracing Algorithm which detects the number plate from the image provides output as number plate with different styles and shapes more effectively and efficiently. Detection and sharpening of the edges is done with the help of canny edge detection algorithm which further enhances the edges of individual characters in the number plate so as to be recognized by further algorithms. This algorithm along with edge detection also enhances the quality of image by filtering the output of previous step which is not done in any of the proposed methodologies. The characters are individually recognized and being matched with the help of matchers and classifiers which are trained and intelligent agents which have various training sets that makes them recognize the individual characters of different shape and size. Thus the final step will give the digital representation of the number of the vehicle's number plate whose image was taken. The proposed algorithms overcomes various drawbacks from previous papers studied so far by reducing computational cost and providing more accurate results for various different kinds of number plates of different styles and shapes.

V. Acknowledgement

An endeavour is successful only when it is carried out under proper guidance & blessings. We would like to thank few people who helped us in carrying out this work by lending invaluable assistance to us in carrying out this work by lending invaluable assistance to us. We are hereby thankful to Prof. Mr. S.R. Sakhare, HOD of Information Technology, VIIT, Pune & Prof. Mr. Mandar Karyakarte Sir, Project Coordinator, Department of Information Technology, VIIT, Pune who encouraged at this venture We sincerely thank Prof. Mrs. J.V. Bagade, Project Guide, VIIT, Pune for their constructive & encouraging suggestions. We also thank all

Teaching Non-teaching staff of IT Dept VIIT, Pune for their kind of co-operation during our course. Finally we are extremely thankful to our Family & Friends who helped us in our work & made the project a successful one.

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