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Novel Approach for Localization of Indian Car Number Plate Recognition System using Support Vector Machine

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Abstract- Enormous incorporation of information technologies into all aspects of recent life caused demand for processing vehicles as conceptual resources in information systems. This work deals with problematic from field of artificial intelligence, machine vision and neural networks in construction of an automatic car number plate Recognition (ACNPR). This techniques deals with enhanced shadow removal algorithm and noval approach for plate localization, along with connected component Analysis method for number plate localization & segmentation. In this paper we used Skeletonization method for feature extraction and Support Vector Machine for character recognition. Work comparatively deals with methods achieving invariance of systems towards image illumination, translations and various light conditions during the capture.

Keywords-Artificial Intelligence, machine vision, neural network, segmentation ,feature extraction, recognition

I. INTRODUCTION

Number plate Recognition technique aims to identify number plate character in real images. Number plate recognition (NPR) is one of the most practical applications of image processing and classification techniques. Generally Number Plate Recognition (NPR) technology has been used for automobile law enforcement purposes. This task is quite challenging due to the different of plate formats and the no uniform outdoor illumination conditions during image acquisition, such as backgrounds illumination, vehicle speeds and distance ranges between the camera and the vehicle. Therefore, most approaches work only under restricted conditions such as fixed illumination, limited vehicle speed, and stationary backgrounds.

The initial objective of the study is to improve a quality in number plate recognition with respect to identification of characters. The successful deployment of such a measure can also potentially lead to improved highway safety, efficiency, and national security. To Design a Car Number Plate Recognition of system, in developed countries the attributes of the number plate are strictly maintained. For example size of the plate, font size, spacing between each character etc are maintained very distinctively. However in India, number plates are not standardized across different states making localization and recognition of plates efficiently difficult. Number Plate Recognition applied to the intelligent transportation system is implemented based on the following aspects: Ambiguous characters recognition such as (B-8), (O-0), (I-1), (A-4), (D-O) characters, Reduction of Illumination problem, Try to identify plates ones with stickers and unofficial stamps affixed on their surface, Variable plate size.

An algorithm for number plate recognition (NPR) applied to the intelligent transportation system is proposed on the basis of a novel shadow removal technique i.e., improved Bernsen algorithm combined with the Gaussian filter [3][10]. In paper [4], algorithm is based on a combination of morphological operation with area criteria tests for number plate localization. Segmentation of the plate characters was achieved by edge detectors, labeling and fill hole approach. The character recognition was accomplished by the process of Template matching. To make number plate numbers more legible, a generalized discontinuity-adaptive Markov random field (DAMRF) model is proposed [8]. Observing that characters in different number plates are duplicates of each other, paper proposed the idea of bag-of-words (BoW) model popularly applied in partial-duplicate image search[9]. A novel scheme to automatically locate number plate by principal visual word discovery and local feature matching.[11] .

A typical system for NPR consists of four parts:

1) Obtaining an image of the vehicle
2) Shadow removal Method
3) Number Plate Localization
4) Character segmentation and standardization
5) Feature Extraction and Character recognition.

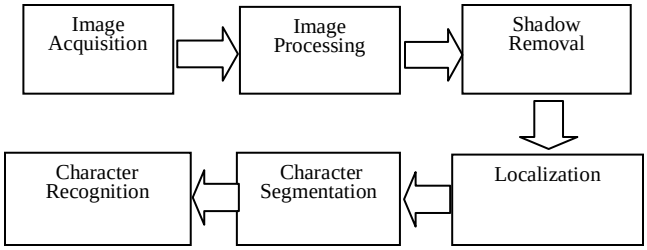

Fig 1 :Car Number Plate Recognition System

II. Number Plate Preprocessing and Shadow Removal Algorithm

Localization of potential license plate regions(s) from Vehicle images are a challenging task due to huge variations in size, shape, color, texture and spatial orientations of license plate regions in such images.Here we captured the vehicle images and stores them in a centralized data server for further processing.

Preprocessing Applied:

1.RGB to Gray Scale Conversion:

From the 24-bit color value of each pixel (x, y) the R, G and B components are separated and the 8-bit gray value is calculated using the formula:

gray(x, y) = 0.59 * R(x, y) + 0. 30 * G(x, y) + 0. 11 * B(x, y)

2. Median Filtering:

Median filtering is a useful in reducing impulsive or salt-and-pepper noise. In median filtering, the neighboring pixels are ranked according to brightness (intensity) and the median value becomes the new value for the central pixel. Here we used 3X3 mask for filtering.

Enhanced Shadow Removal algorithm:

The brightness distribution of various positions on a license plate image may vary due to the condition of the plate and the effect of the lighting environment. During the number plate recognition procedure, the global threshold value method provides better computation efficiency if the vehicle images are obtained under uniform illumination and without noise, but in most cases, the environment around the number plate is complex and the illumination is un even, so the performance of a single binary threshold is poor.

In this study the Gaussian Laplace operator is combined with an iterative method. When illumination is even, the iterative method is adopted; when illumination is uneven, the Gaussian Laplace operator is adopted. Suppose that $f(x, y)$ denotes a gray value of point (x, y). Consider a block whose center is a point (x, y).

Steps:

1. Apply the Gaussian filter on the image.
2. The threshold $T(x, y)$ of $f(x, y)$ is computed by : $T(x,y)=(\max(f(x,y)) + \min(f(x,y)))/2$.
3. Find difference as: $Diff=(\max(f(x,y)) - \min(f(x,y)))$;
4. Now fine final threshold as: If diff>= constant_th then final_th=T(x, y)
   Else final_th=128;
5. Obtain a binary image by : f(x, y)= 255 if f(x,y)>final_th;
   0 otherwise

Fig 2 : Processing task of simple image:(a) a sample RGB car image (b)RGB to Gray conversion of image (c)Image after applying median filter (d)Image after applying Enhanced shadow removal image

III. Number Plate Localization

In general, objective of any Number Plate Recognition (NPR) system is to localize potential license plate region(s) from the vehicle images captured through a road-side camera and interpret them using an Optical Character Recognition (OCR) system to get the license number of the vehicle. In our paper we used noval approach for localization of license plate.

Noval localization Method:
1) Take input as a binary image.
2) Find all the properties of image and also find number of connected component in image.
3) Prepare histogram for image and find the number of regions in one bins and its position.
4) After above steps we find the region with maximum connected objects & also find whether they are in same row or not.
5) Finally we crop that region as a localized license plate.

Fig 3: Car image after localization of number plate

IV. Number Plate Segmentation

Image segmentation plays an important and critical step that lead to the analysis of the processed image data. In order to extract and analyzed the object characteristic, the process need to partition the image into different parts that will have a strong correlation with the objects. Here first we apply the adaptive thresholding filter to enhance an area of the plate before segmentation. The adaptive thresholding is used to separate dark foreground from light background with non-uniform illumination. After the thresholding, we compute connected component Analysis for the number plate.

Connected Component Analysis Method:
Once license plate have been detected, it is often useful to extract regions which are not separated by a boundary. Connected components labeling scans an image and groups its pixels into components based on pixel connectivity, *i.e.* all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. Once all groups have been determined, each pixel is labeled with a gray level or a color (color labeling) according to the component it was assigned to.

Connected component analysis works by scanning an image, pixel-by-pixel (from top to bottom and left to right) in order to identify connected pixel regions, *i.e.* regions of adjacent pixels which share the same set of intensity values *V*. (For a binary image *V={1}*; however, in a gray level image *V* will take on a range of values, we assume binary input images and 8-connectivity. The connected components labeling operator scans the image by moving along a row until it comes to a point p (where p denotes the pixel to be labeled at any stage in the scanning process) for which V={1}. When this is true, it examines the four neighbors of p which have already been encountered in the scan (i.e. the neighbors (i) to the left of p, (ii) above it, and (iii and iv) the two upper diagonal terms). Based on this information, the labeling of p occurs as follows:
i)If all four neighbors are 0, assign a new label to p, else
ii) if only one neighbor has V={1}, assign its label to p, else
iii) if more than one of the neighbors have V={1}, assign one of the labels to p and make a note of the equivalences.

After completing the scan, the equivalent label pairs are sorted into equivalence classes and a unique label is assigned to each class. As a final step, a second scan is made through the image, during which each label is replaced by the label assigned to its equivalence classes. For display, the labels might be different gray levels or colors.

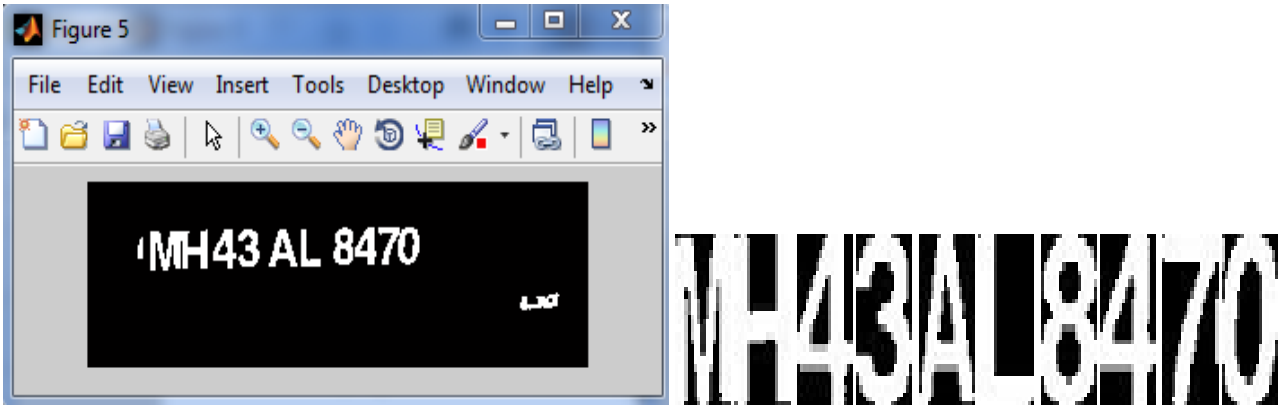

Fig 4: Segmented car image

V. Feature Extraction & Character Recognition

The task of the feature extraction and selection methods is to obtain the most relevant information from the original data and represent that information in a lower dimensionality space. Relevant information from the original data and represent that information in a lower dimensionality space. There are many such techniques, here we used Principal Component Analysis(PCA) Method to find feature vector[7].

PCA method for finding feature vector:

1) Define an initial set of training patterns. Each pattern Pi of the set, where 1<=i<=m , belongs to some of the classes. Also we assume that Pi is a n x 1 vector.

2) Calculate the average vector of the training set.$Y = \frac{1}{m}\sum_{i=1}^{m} p_i$

3) From the initial set of training patterns, define matrix A (the pattern space), putting in each of its columns one of the m training patterns, subtracted from it the average vector Y:A = [P1 – Y, P2 - Y ,... Pm - Y] , the obtained A matrix has then size n x m.

4) Calculate the eigenvectors of the covariance matrix of the set of training patterns. This matrix, named C, will be defined as: $C = AA^T$

5)Select p eigenvectors of C to compose the principal component matrix, where p £ m. The selected eigenvectors are columns of matrix U related to the biggest Eigen values found in computing the eigenvectors of the covariance matrix. The selection is done in order to keep in matrix U only the selected p eigenvectors:

U = [U1 U2 ... Up]

In this project Support Vector Machine is used for character recognition. Support Vector Machines (SVMs) are a relatively new supervised classification technique, have gained importance because they are robust, accurate and are effective even when using a small training sample. SVM-based classification has been known to strike the right balance between accuracy attained on a given finite amount of training patterns and the ability to generalize to unseen data.

Support Vector Machine:

We used Support Vector Machines, a method for the classification of both linear and nonlinear data. A support vector machine (or SVM) is an algorithm that works as follows. It uses a nonlinear mapping to transform the original training data into a higher dimension. Within this new dimension, it searches for the linear optimal separating hyper plane (that is, a "decision boundary" separating the tuples of one class from another). With an appropriate nonlinear mapping to a sufficiently high dimension, data from two classes can always be separated by a hyper plane. The SVM finds this hyper plane using support vectors and margins (defined by the support vectors).

We also used kernel function, K(Xi, Xj), to the original input data. That is,

$K(Xi, Xj) = \phi(Xi) . \phi(Xj)$.

In other words, everywhere that $\phi(Xi) .\phi(Xj)$ appears in the training algorithm, we can replace it with K(Xi;Xj). In this way, all calculations are made in the original input space, which is of potentially much lower dimensionality!

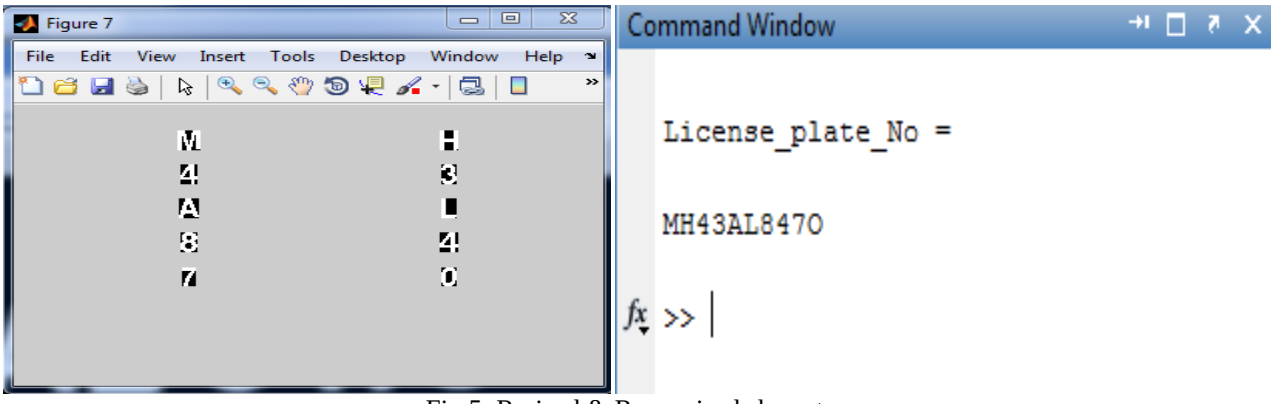

Fig 5: Resized & Recognized character

VI. Results and Conclusion

Above system aims to identify Indian number plate with minimum restriction i.e. With different font type, different font size, different plate size, different background of number plate. Even in this project we have not only taken car plate region area also we took whole car image with variable distance between car and camera. To achieve required result different algorithms are used for shadow removal, plate localization, plate segmentation. Preprocessing of detected number plate is done to improve plate results. As per literature review, there are different noise removal methods; in this project median filter is used. Image segmentation is done using connected component analysis method which takes minimum processing speed and highly accurate. Skeletonization is used to generate feature vector. This feature vector is used by Support Vector Machine for

character recognition. It is an algorithm for the classification of both linear and nonlinear data. It is a very highly accurate, and having less over fitting problem. Here speed is the issue with the algorithm as it is developed in matlab. It takes around 14 seconds to recognized plate.

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