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A Novel Approach of Vehicle License Plate Detection System for Indian Vehicles

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Abstract –**This paper presents the license plate recognition technology, which consists of the following steps: image preprocessing, segmentation and recognition of numbers. This technology allows to recognize license plates with good accuracy in terms of day and night, and when there is significant inclination license plate. For pre-processing, Gray conversion and Weiner filtering are used. Segmentation is performed using the morphological operations, which increase the efficiency of the subsequent binarized license plate. Thus avoiding rotation of the plate and, consequently, the additional loss of quality. Finally template matching is performed to recognize the character in license plate. The proposed technology can likewise be used for segmentation and recognition of various text data.**

Keywords –**Gray Conversion, Morphological Operations, Weiner Filtering.**

I. Introduction

The problem of recognition of vehicle numbers are often solved in difficult conditions: in all weather conditions, lighting, dirty license plates. The solution to this problem is required in applications such as the management of road traffic, automatic processing of traffic accidents, the automatic parking.

Noisy and tilt license plate are serious problems arising in the development of such systems. The existing segmentation methods include mathematical morphology methods, selection borders, Hough transformation, horizontal and vertical projection [1], AdaBoost algorithm [2], convolutional neural networks (CNS) [3]. To solve the problem of recognition of commonly used decision trees, hidden Markov models, support vector machines, pattern matching, various algorithms based on artificial intelligence: multilayer perceptrons, neural networks [4, 5], CNS and others.

License plate recognition is one of the most rapidly evolving technologies in the field of video based surveillance and control. It is sometimes also referred to as Automatic number plate recognition (ANPR) or automatic vehicle detection system. As the name implies, it first detects the license plate from the input frame and recognizes the vehicle as well its owner based on its license plate information. Since its first use in 1976 by UK Police, this technology has gone through a lot of changes and is now being extensively used in law enforcement field. One of the key applications has been in access control for gated communities and other such restricted access locations. In such places, license plate information of all the authorized vehicles is stored in a database and only these vehicles are allowed to enter the premises. This can be extremely useful in safeguarding intelligence agencies and other such key government buildings from any external threat. Automated traffic management is another field where license plate recognition has contributed immensely. It is widely used for toll collection, speed control and accident scene reconstruction. The success for fixed camera applications encouraged authorities to use this technology for mobile camera based surveillance. The use for mobile applications had its own challenges especially in terms of power efficiency since vehicle battery was used as a power source. Another challenge was processor speed as all the systems need to be real time. In recent years, the semiconductor technology has grown immensely which has contributed in improving power performance of electronic equipment as well as reducing its size. This has helped in developing portable surveillance systems which can be easily mounted on vehicle top. This has proven to be an important tool for police officials in solving traditional criminal investigations. Our aim is to develop an algorithm which accurately recognize the license plates given as input. The overall objective may be subdivided into two distinct key modules:

- Segmentation of the characters within the license plate and
- Recognition of segmented characters within the license plate.

II. System Model

The proposed method is designed for Vehicle License Plate Detection for Indian vehicles. In Figure 1 the method for proposed System is depicted. Rest of methodology is described in following subheadings.

A. Pre-processing

In this module firstly an input RGB image is taken from an external source such as database or camera which is converted to gray scale. Generally, the image obtained contains some irrelevant information or impurities such as holes, dirt particles and the background which must be removed. The noise is removed using filtering.

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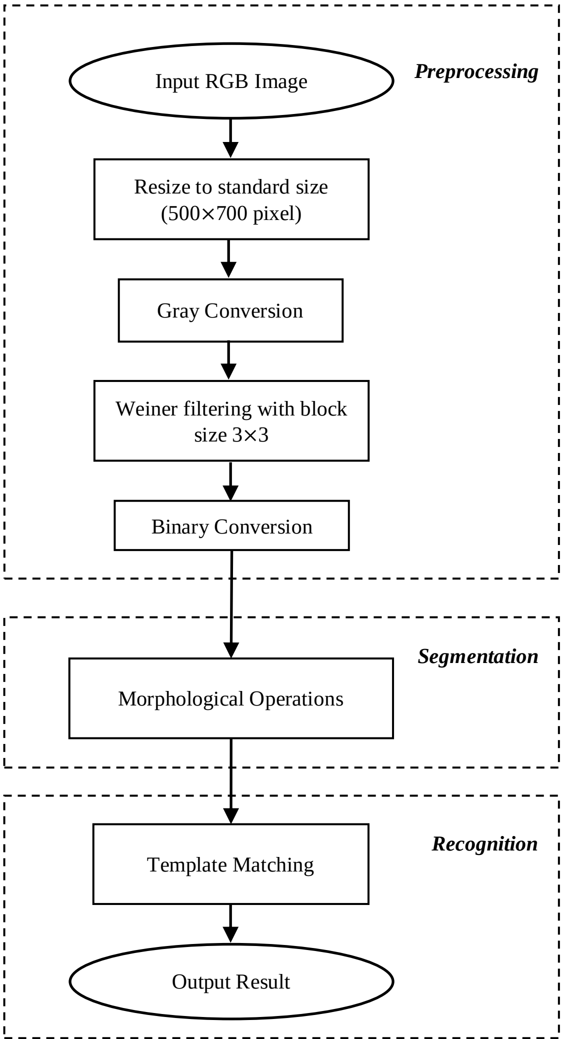

Figure 1: Flow diagram for proposed research work

Following operations are performed in pre-processing phase:

- Initially an RGB image is taken as input.

Figure 2: RGB input image

- *Resize to Standard Size (500×700 Pixel)*

Figure 3: Resizing

- *Gray Conversion of Resized Image*

Figure 4: Gray conversion

- Weiner filtering with block size 3×3

Figure 5: Filtered image

Wiener filtering is used to face the problems such as colour distortion while using dark channel prior when the images with large white area is being processed. Wiener filter also decreases the running time of algorithm.

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- Binary conversion

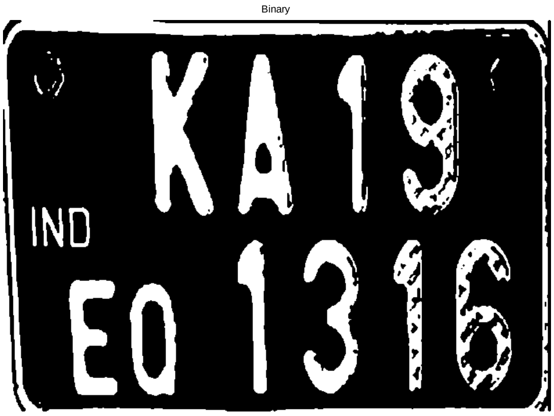

Figure 6: Binary image

B. Segmentation using Morphological Operations

Segmentation is part of the data reduction stage and involves the partitioning of the image plane into meaningful parts, such that "a correspondence is known to exist between images on the one hand and parts of the object on the other hand" [6].

C. Binary Morphology

In binary morphology, everything could be defined using the set operations. Formally, let I and B are the sets corresponding to the image and structuring element, then

$$I = \{(x, y) \mid I[x, y] <> 0, \forall x, y \in I_R\} \quad (1)$$

Where I_R is the set of all possible (row, column) elements over and image I. B can be defined in a similar manner.
There are two basic operations in morphology, which are called dilation and erosion.
The dilation of I by B is denoted by $I \oplus B$ and it is defined as:

$$I \oplus B = \{c \mid c = i + b, where\ i \in I, b \in B\} \quad (2)$$

In the mathematics literature, the dilation is also called as Minkowski addition to refer the inventor of the operator. To complete the dilation operation, B should be translated to the every image pixel and the union of the result should be taken as an overall result. Therefore, to be precise, translation of a set should be defined to shift the structuring element to a specific image point.
The translation of set B by t is defined as follows:

$$B_t = \{c \mid c = b + t, \forall b \in B\} \quad (3)$$

Dilation operation is defined as follows:

$$Dil(I, B) = \cup_{t \in I} I \oplus B_t \quad (4)$$

In the same sense, erosion and erosion operations are defined as in Equations (4), (6) respectively.

$$I \Theta B = \{c \mid c = i - b, i \in I, b \in B\} \quad (5)$$

$$Ero(I, B) = \cap_{t \in I} I \Theta B_t \quad (6)$$

Figure 7: Perform morphological dilation with disk structure of radius **5** pixel

Figure 8: Perform morphological opening, remove white areas less than 40000 sq. pixel

Figure 9: Clear boundary white pixels

By using the primitive operations, several morphological operations can be defined. The two basic compound functions that could be constructed by using dilation and erosion are opening and closing respectively. The opening could be defined as dilating an image after eroding. The closing could be defined as eroding and image after dilating.

These operations could be understood by exploring the practical meaning of the basic operations. Since dilation constructs a set that is dilation of the umbrae of the image and structuring element, it makes the high intensity parts of the image grow, and in the similar sense, erosion makes them shrink.

So when an image is opened by a structuring element, it is first eroded and some of the small dark areas disappear, then it is dilated and somehow the structures

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larger than the structuring element are restored to their original form. As overall processes it is a smoothing operation that removes the small parasitic areas and smoothes the object contours.
The opening of a set I by structuring element B is defined as:

$$I \circ B = (I \ominus B) \oplus B \quad (7)$$

Similarly, the closing of a set I by structuring element B is defined as:

$$I \cdot B = (I \oplus B) \ominus B \quad (8)$$

Finally isolate objects in image reading line wise (left to right in each line). Resize each object to 150×100.

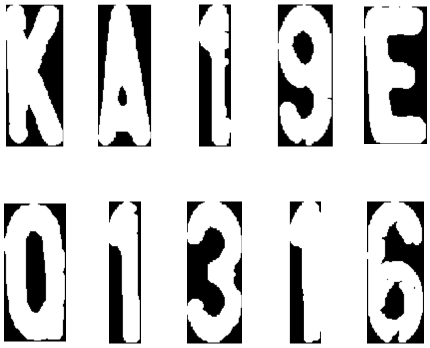

Figure 10: Object isolation

D. Recognition using Template Matching

In this module the labeled characters are retrieved and recognized. The templates loaded are resized to the size of recognized characters. Normalized cross correlation template matching is used to find the best match. Templates from an existing template set are selected and resized according to the size of the components discovered in the process. Resizing is done in such a way that the scale variance is minimized. In the proposed algorithm, the height and width of the template image is resized to the height and width of the characters of the processed image. Normalized Cross Correlation is performed between the components and the template image to find the degree of similarity between them. The value is obtained is compared to a given threshold. If the value of cross correlation is greater than the proposed threshold then the original threshold value is updated to the new one. If more than one correlation values exceed the previous threshold then threshold is updated to the highest among these values for the best match. The matched characters are retrieved and the result is stored in a text file.

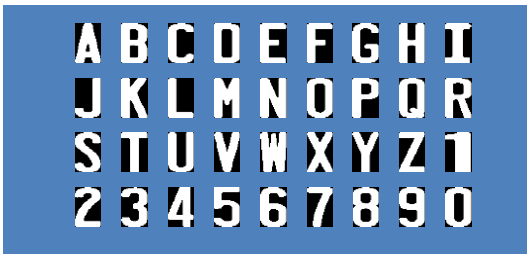

Figure 11: Perform template matching from this template

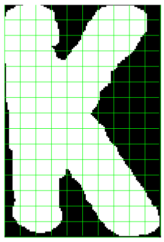

Figure 12: Divide each letter in blocks, block size (10×10), total blocks 150

Then, count number of white pixel in each block, total 150 value will be there, one for each block

	1	2	3	4	5	6	7	8	9	10
1	68	98	84	11	0	16	82	90	74	4
2	100	100	100	41	0	78	100	100	99	8
3	100	100	100	35	33	100	100	100	56	0
4	98	100	100	62	94	100	100	66	3	0
5	90	100	100	100	100	100	86	3	0	0
6	90	100	100	100	100	100	33	0	0	0
7	81	100	100	100	100	85	2	0	0	0
8	70	100	100	100	100	85	9	0	0	0
9	70	100	100	100	100	100	60	0	0	0
10	57	100	100	100	100	100	100	28	0	0
11	50	100	100	96	92	100	100	87	6	0
12	50	100	100	55	30	100	100	100	62	0
13	38	100	100	50	0	72	100	100	100	25
14	44	100	100	65	0	15	97	100	100	82
15	3	46	66	19	0	0	30	86	86	54

Figure 13: Number of white pixel in each block

Normalize Feature: Divide each value by maximum value in matrix and save it as a column vector.

	1	2	3	4	5	6	7	8	9	10
1	0.6800	0.9800	0.8400	0.1100	0	0.1600	0.8200	0.9000	0.7400	0.0400
2	1	1	1	0.4100	0	0.7800	1	1	0.9900	0.0800
3	1	1	1	0.3500	0.3300	1	1	1	0.5600	0
4	0.9800	1	1	0.6200	0.9400	1	1	0.6600	0.0300	0
5	0.9000	1	1	1	1	1	0.8600	0.0300	0	0
6	0.9000	1	1	1	1	1	0.3300	0	0	0
7	0.8100	1	1	1	1	0.8500	0.0200	0	0	0
8	0.7000	1	1	1	1	0.8500	0.0900	0	0	0
9	0.7000	1	1	1	1	1	0.6000	0	0	0
10	0.5700	1	1	1	1	1	1	0.2800	0	0
11	0.5000	1	1	0.9600	0.9200	1	1	0.8700	0.0600	0
12	0.5000	1	1	0.5500	0.3000	1	1	1	0.6200	0
13	0.3800	1	1	0.5000	0	0.7200	1	1	1	0.2500
14	0.4400	1	1	0.6500	0	0.1500	0.9700	1	1	0.8200
15	0.0300	0.4600	0.6600	0.1900	0	0	0.3000	0.8600	0.8600	0.5400

1	0.6800
2	1
3	1
4	0.9800
5	0.9000
6	0.9000
7	0.8100
8	0.7000
9	0.7000
10	0.5700
11	0.5000
12	0.5000
13	0.3800
14	0.4400
15	0.0300
16	0.9800
17	1
18	1
19	1
20	1
21	1
22	1

Figure 14: 150 values of normalized feature

Match with each of 36 templates using Euclidian distance.
In mathematics, a Euclidean distance matrix is an n×n matrix representing the spacing of a set of n points in space. According to the Euclidean distance formula, the distance between two points in the plane with coordinates (x, y) and (a, b) is given by:

$$dist\{(x,y),(a,b)\} = \sqrt{(x - a)^2 + (y - b)^2} \quad (9)$$

Minimum distance will be the matched one and finally Figure 15 shows the recognized result.

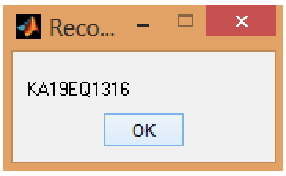

Figure 15: Recognized characters of number plate

III. Simulation and Results

Simulation is performed with MATLAB 2010a.

Figure 16: RGB input image

Figure 17: Resizing

Figure 18: Gray conversion

Figure 19: Filtered image

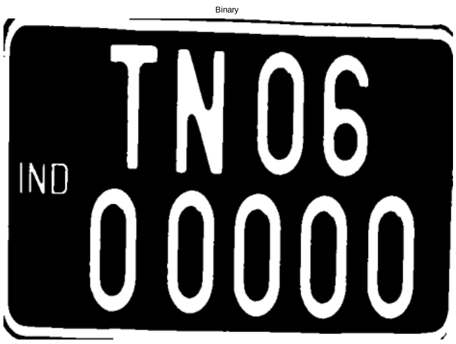

Figure 20: Binary conversion

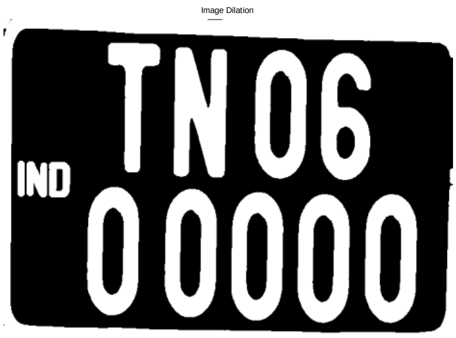

Figure 21: Perform morphological dilation with disk structure of radius 5 pixel

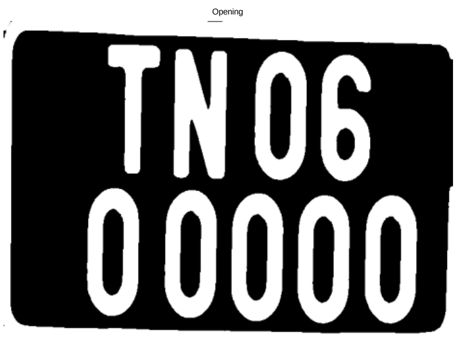

Figure 22: Perform morphological opening, remove white areas less than 40000 sq. pixel

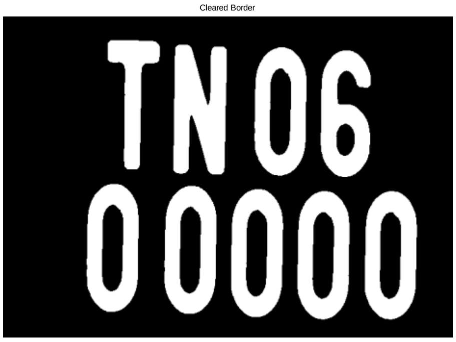

Figure 23: Clear boundary white pixels

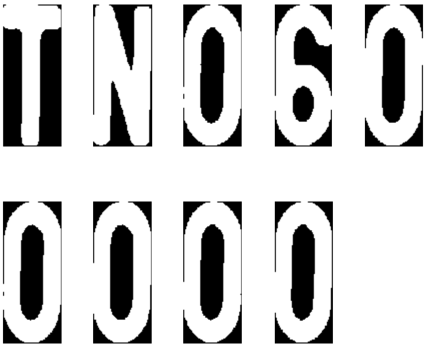

Figure 24: Object isolation

Above figure is isolated characters

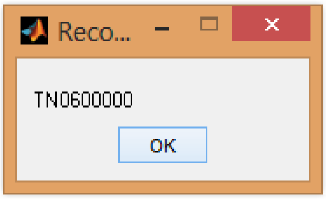

Figure 25: Recognized characters of number plate

IV. Conclusion

Vehicle License Plate Recognition is a pattern recognition approach with great importance in vehicle counting, traffic surveillance and law enforcement. Consequently, number of algorithms have been proposed in recent times for efficient disposal of the application.

This paper presents Vehicle License Plate Recognition System based on morphological operations and template matching. Scale variance between the characters was reduced by maximizing the correlation between the templates. An algorithm is proposed to cope with scale variance by using template matching with Normalized Cross Correlation. Simulation results show that the proposed approach successfully recognized the character of license plate.

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