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Automatic Number Plate Recognition by Using Matlab

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Abstract: *In this thesis work the text found on the vehicle plates is detected from the input image and this requires the localization of number plate area in order to identify the characters present on it. In this thesis work, simple colour conversion edge detection and removal of noise with the application of median filter as one of the operators is attempted. This thesis work presents an approach using simple but efficient morphological operations, filtering and finding connected components for localization of Indian number plates .It proposes the identification of stolen cars .The algorithm has been tested on 20 samples and is found to extract both alphabets and numbers from vehicle license plates images with an accuracy of 90% for four wheeler license plates.*

Keyword: *Edge Detection, Median Filtering, morphological operations, Bounding Box Segmentation*

1. INTRODUCTION

Every country uses their own way of designing and allocating number plates to their country vehicles. This license number plate is then used by various government offices for their respective regular administrative task like- traffic police tracking the people who are violating the traffic rules, to identify the theft cars, in toll collection and parking allocation management etc. In India all motorized vehicle are assigned unique numbers. These numbers are assigned to the vehicles by district-level Regional Transport Office (RTO). In India the license plates must be kept in both front and back of the vehicle. These plates in general are easily readable by human due to their high level of intelligence on the contrary; it becomes an extremely difficult task for the computers to do the same. Many attributes like illumination, blur, background colour, foreground colour etc. will pose a problem. Also, the License Plate Recognition (LPR) in India is difficult because the traffic rules are hardly obeyed and the number plate standards are not strictly practiced. Each one is adopting a different style leading to obtaining variation in parameters like, size of number plate and characters, location of number plate, type of font used, background (white background with black letters for non-commercial vehicles and white background with yellow letters for commercial vehicles), different unwanted pictures etc. which makes the task of number plate localization very difficult. The main aim of this article is to implement an efficient method to recognize license plates and extract text from them under Indian conditions.

This work is carried over for on car number plates. But this can be applied to any type of motor vehicle. A typical example of an Indian license plate (for car) is shown in the figure 1 with the significance of each character (1. State Co de, 2. District Code, 3.Type of Vehicle (car, two wheeler, commercial etc.) 4. Actual Registration Number). In this we can observe that the license plate is represented with various font size for the state code, district code, type of vehicle and registration number. A sample two wheeler license plate is given in figure 1. Thus in India there is no defined alienation followed for writing the license number plates.

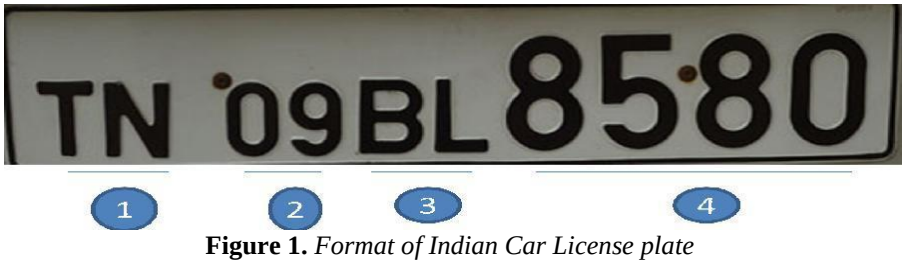

Figure 1. *Format of Indian Car License plate*

2. RELATED WORK

In this paper the text found on the vehicle plates is detected from the input image and this requires the localization of number plate area in order to identify the characters present on it. In literature we can find many methods for number plate detection and recognition system. The major drawback is that how long it will take to compute and recognize the particular license plates. This is critical and most needed when it is applied to real time applications. However, there is always a trade-off between computational time and performance rate. In order to achieve an accurate result and increase the performance of the system more computational time is required. For number plate detection or localization, techniques based on edge statistic and mathematical morphology gives a very good result that uses vertical edge information to calculate the edge density of the image followed by morphology methods such as dilation to extract the region of interest. This technique works well due to the fact that number plates always have high density of vertical edges. But in this method as unwanted edges in the background are also detected which leads to confusion, it is difficult to apply this method for number plates with complex background.

Colour based techniques are proposed in this thesis work. The draw back with this method is that it performs well when the lighting condition is constant but when there is various illumination condition its performance reduces. But in real-time application normally the images can be obtained with various lighting illumination. Furthermore, the proposed technique is country specific because each country will have different colour code for vehicle number plate. Connected Component Analysis (CCA) method is used to detect the number plate region. CCA is useful for simplifying the detection task .since it labels binary image into several components based on their connectivity. Based on the problem one can decide on the selection of finding the connected components using 4-adjacency or 8-adjacency of pixels connectivity. Spatial measurement is a measure of spatial characteristics of a connected component such as area, orientation, aspect ratio etc. and filtering is done to eliminate unrelated or unwanted components. When Connected Component Analysis is combined with spatial measurement and filtering produces better result in number plate detection. Automatic recognition of car license plate number became a very important in our daily life because of the unlimited increase of cars and transportation systems which make it impossible to be fully managed and monitored by humans, examples are so many like traffic monitoring, tracking stolen cars, managing parking toll, red-light violation enforcement, border and customs checkpoints. Yet it's a very challenging problem, due to the diversity of plate formats, different scales, rotations and non-uniform illumination conditions during image acquisition.

This paper presents an approach using simple but efficient morphological operations, filtering and finding connected components for localization of Indian number plates. The algorithm has been tested on 20 samples and is found to extract both alphabets and numbers from vehicle license plates images with an accuracy of 90% for four wheeler license plates of different regions in different climatic conditions. HD number plates are also identified by resizing them to aspect ratio.

3. RELATED DEFINITIONS

A detection algorithm that employs mathematical morphology, structuring element, median filtering, edge detection to detect the license plate is detailed below.

3.1 Mathematical Morphology

Mathematical Morphology is set-theoretic method for analysing the image and extracting image components that are useful in the shape representation and extraction of geometrical structure. They are used to detect boundaries of objects, their skeletons, and their convex hulls. These are the basic operations that has to be carried over for any image pre- and post-processing techniques, that include edge thinning, thickening, region filling ,pruning etc.,. The following operations form the basis of mathematical morphology.

Dilation:

Dilation will cause objects to grow in size as it will exchange every pixel value with the maximum value within a 3x3 window size around the pixel. That is it adds pixels to the boundaries of objects in an image. The process may be repeated to create larger effects. The size

and shape of the structuring element decides the number of elements to be added to the image under processing.

Erosion:

Erosion works the same way except that it will cause objects to decrease because each pixel value is exchanged with the minimum value within a 3x3 window size around the pixel. That is it removes pixels from the boundaries of objects in an image. The size and shape of the structuring element decides the number of elements to be removed from the image under processing.

Opening:

Opening is an important morphological operator. It is defined as erosion, followed by dilation. Erosion tries to eliminate some of the foreground (bright) pixels from the edges of regions of foreground pixels. The disadvantage is that it will remove all regions of foreground pixels indiscriminately. Opening gets around this by performing both erosion and dilation on the image.

Closing:

Closing is similar in some ways to dilation in that it tends to enlarge the boundaries of foreground (bright) regions in an image (and shrink background colour holes in such regions), but is less destructive of the original boundary shape. Closing is defined as dilation, followed by erosion. The effect of the operator is to preserve *background* regions that have a similar shape to this structuring element, or that can completely contain the structuring element, while eliminating all other regions of background pixels.

3.2 Structuring Elements

In order to carry over the dilation and erosion operations on images the structuring element are used. A structuring element is a matrix with m* n size. The values in this matrix are of binary value that is either a 1 or 0. The pixels with values of 1 next to each other are called the neighbourhood pixels.

In a morphological operation, the origin of the structuring element is compared with every pixel along with its neighbours in the input image and translated to each pixel position in the corresponding output image. The outcome of this comparison depends upon the type of morphological operator and size of structural element used. Sample structuring elements are given in figure 2.

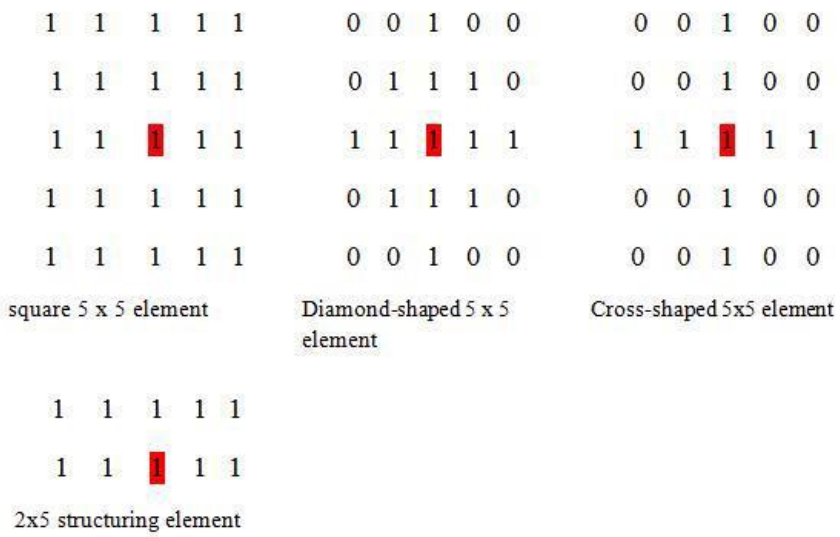

Figure 2. *Examples of simple structuring elements*

The red colour in each matrix represents the origin. This paper uses a (2, 4) structuring element.

3.3 Median Filter

The median filter is a non-linear filtering technique used to remove noise from image under consideration. While it helps in removing the impulse noise it preserves the edges. As the impulse

noise spikes are much brighter than their neighbouring pixels, they are generally placed in the extreme top or bottom end of the brightness ranking while analysing the neighbourhood of input pixels. As a consequence, these extremes values with noise which lie far away from the median value are removed by the filter which leads to dramatic reduction of noises from the image. Repeated application of median filter make the image with uniform regions that are very effective when classified for segmentation. Because of its nonlinearity it is unsuitable for common optimization techniques. As a matter of fact, median filter is a statistical non-linear filter that is often described in the spatial domain. A median filter also smoothens the image by utilizing the median of neighbourhood. In this experiment, a 2×4 median filter is used mainly because, this filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges. It behaves like low-pass filtering in smoothening and reducing the noise in the image while preserving discontinuities and smooth the pixels whose values differ significantly from their surroundings without affecting the other pixels which is lacking in low-pass filters.

4. METHODOLOGY ADOPTED

Generally the text in number plates are written with contrast background and foreground like black letters on white background and black letters on yellow background and based on this property of text a localization technique has been proposed in this paper. The work is divided into three major parts namely pre-processing, text localization and extraction and text/non-text classification.

4.1 Pre-processing

In the pre-processing step, the coloured input image is converted to grey scale image. The image is then binarised. A binarised image is a must for doing all morphological operations like opening, closing, thinning, skeletonization, region filling etc. To this binarised image median filtering is applied to remove any noise if presents. Edge detection algorithm is applied on the resultant image to extract the edges.

4.2 Text localization and Extraction

In this phase, the morphological dilation operation is performed on the edge image obtained from the previous step. Since texts are normally aligned in the horizontal direction a 2x4 rectangular structuring element is used. All Connected Components are then extracted.

4.3 Text/non-text classification

The extracted components from the above step contains both text and non-text components. They are separated and eliminated by a two way process. First, the initial bounding boxes are drawn for all objects (figure 3). The required texts in the connected components are extracted and placed in a jpeg file.

Figure3

The flowchart explaining the algorithm is given in figure 4.

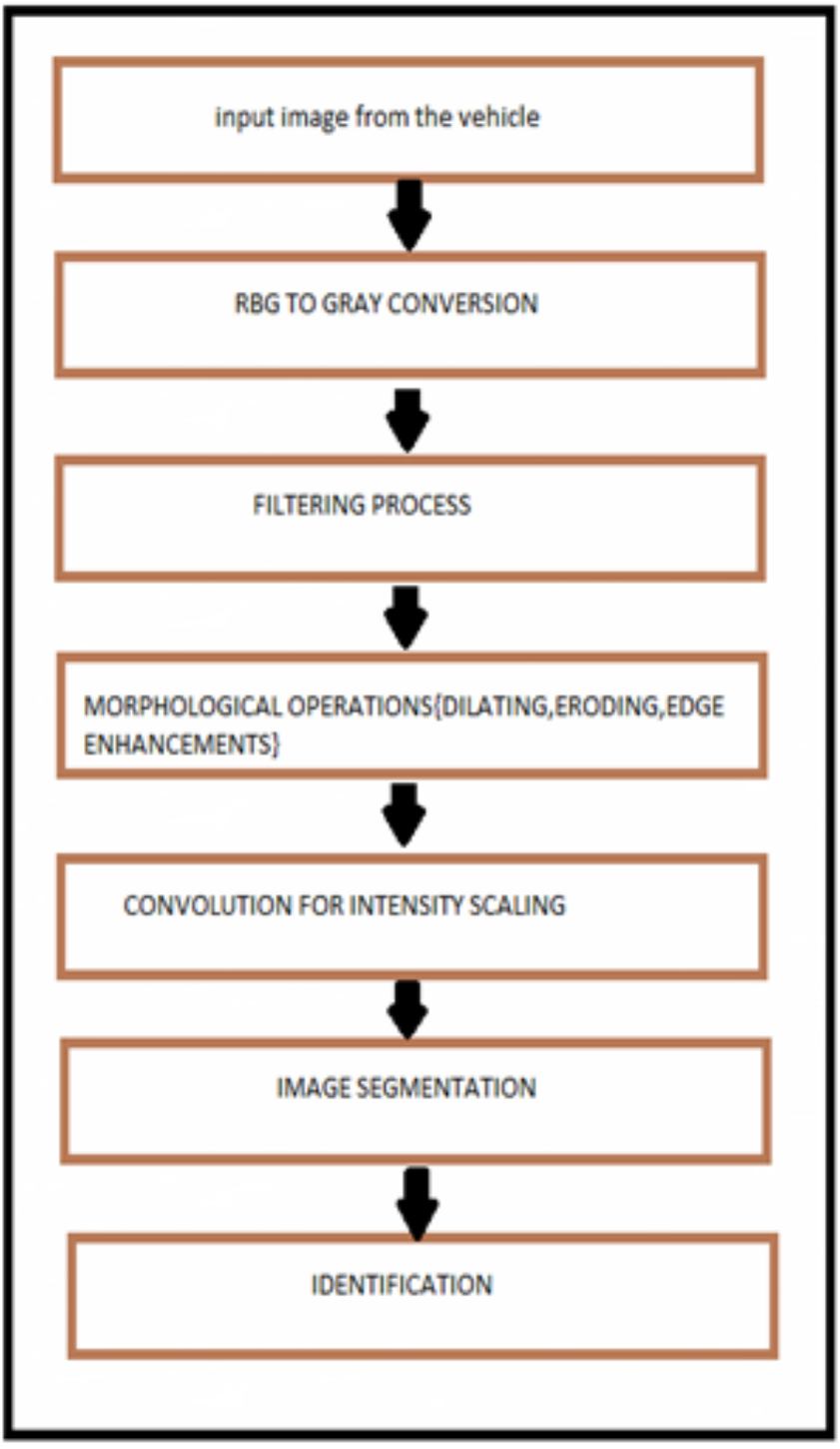

Figure 4. *The proposed algorithm for extraction of number plates*

5. RESULTS AND ANALYSIS

The tests were conducted on 20 images taken with the help of 10mega pixels digital camera and MATLAB R2013b software was used for the experiment. About 90% of the number plates were localized correctly and 10% images resulted in the localization of number plates along with unwanted non candidate regions, because of the damage in the number plates. Except for the unwanted regions, the algorithm works robust under different illumination and brightness.

The following table 1 shows the extracted text\non text from some of the vehicle number plates and their authentication.

Table 1.

INPUT IMAGE	OUTPUT OBSERVED
	AP31CH6362 Match not found, AUTHORISED CAR >>
	AP09CD3609 Match not found, AUTHORISED CAR >>
	AP31AT2662 Match not found, AUTHORISED CAR >>
	AP31CU0856 Match Found! STOLEN CAR >>
	AP31CQ3438 Match Found! STOLEN CAR >>

6. CONCLUSION

This article proposes a text localization and extraction technique from vehicle number plates. The suggested method is tested with various types of vehicles with different background and different climatic condition. Differentiation of characters from numbers had been done in our project. Some characters and numbers have similar shape and it becomes difficult to compare with template .In this case we used a condition to eliminate confusion between numbers and characters Usually in Indian number plates we observe alphabets in 1,2,4,5 positions. Hence in this positions segmented characters correlates with templates and when maximum co-relation occurs in that position alphabet is recognized. Except in these positions all the other must be numbers. Then template in data base co-relates with 2,3,6,7, 8,9,10 positions and when maximum correlation is observed then it must be a number. Hence confusion between alphabet and numbers is eliminated. HD number plates can also be recognized as they are reduced to default aspect ratio. In our project stolen cars can be identified by an array in database of Matlab. We have tested 20 number plates of different vehicles in different climatic conditions and we got 18 successful outputs. **Success rate of our project is 90%.**

7. FUTURE SCOPE

Due to the varying characteristics of the license plate among countries/regions further research is still needed in this area. Different-filtering techniques can be introduced to reduce the noise. The integration of multiple algorithms for image segmentation in addition to Sobel-edge detection and binary image segmentation can be considered. In future the extraction of multi-plates, high definition plate processing, multi-style plates can be done.

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