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License Plate Detection and Recognition

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ABSTRACT

Automatic License Plate Recognition (LPR) is a technique involving image processing which is used to identify a vehicle by reading its license plate. In this paper we propose a system which is capable of extracting the license plate region from the vehicle's image taken from its rear end. The system consists of a digital camera, software to interface the camera with the software module and the software module which extracts and recognizes the license plate number. The camera captures the image of pre-defined resolution and passes it to the software module. The software module forms the heart of the entire system. It analyzes the input image, identifies the location of the license plate, segments the characters on it and recognizes the characters. The plate region is extracted by using three different method including VEDA, MSER, SIFT. The characters in the license plate are segmented using digital image labeling and character recognition is done using template matching. The algorithm is implemented in MATLAB. Keywords - License Plate Recognition, LPR, VEDA, ULEA, MSER, canny edge, SIFT, Extrema, keypoints

Key words: License Plate Recognition (LPR), VEDA, ULEA, MSER, canny edge, SIFT.

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I. INTRODUCTION

Vehicles in each country have a unique license number, which is written on its license plate. This number distinguishes one vehicle from the other, which is useful especially when both are of same make and model. Number plates are easily recognized by humans but not by any machine.

The study of Number plate recognition system is a field of research in artificial intelligence machine vision, pattern recognition and neural networks. There are four stages of number plate recognition system such as vehicle image obtain, license plate location and segmentation, character segmentation and standardization, character recognition. The license plate location and segmentation is an important research topic of LPR. Because of different illumination conditions and various complex backgrounds, how to segment license plate fast and accurately from license images is a recognized problem. The quality of locating operation will directly influence the accuracy and the speed of entire system.

In India, the number plate containing white background with black foreground color for private cars and for the commercial vehicle used yellow as background and black as foreground color. The number plate having 10 alphanumeric numbers containing alphabets and numeric no. The number plate start with two digit letter “state code” followed by two digit numeral followed by 6 alphanumeric no. in which last 4 are digits, represents vehicle registration numbers.

II. CHALLENGES

In the developed countries and in most of the developing countries the attributes of the license plates are strictly maintained. For example, the size of the plate, color of the plate, font face, font size, font color of each character, spacing between subsequent characters, the number of lines in the license plate, script etc. are maintained very specifically.

III. IMPLEMENTED METHODOLOGY

Automatic License Plate Recognition System is still in its infantry. The plate region extraction is the most challenging part of the entire system and only a few methods have been proposed for it. We are using three methods for plate region extraction or plate region localization.

1. Vertical edge based license plate detection method using Morphology approach
2. MSER Method
3. License plate recognition system based on SIFT features

IV. BLOCK DIAGRAM

Vertical Edge based car license plate detection method using morphological approach**.**

The VEDA is proposed and used for detecting vertical edges; the proposed CLPD method processes low-quality images produced by a web camera. The computation time of the CLPD method is less than several methods. In this paper, the color input image is converted to a grayscale image, and then, adaptive thresholding (AT) is applied on the image to constitute the binarized image. After that, the ULEA is applied to remove noise and to enhance the binarized image. Next, the vertical edges are extracted by using the VEDA. The next process is to detect the LP; the plate details are highlighted based on the pixel value with the help of the VEDA output. Then, some statistical and logical operations are used to detect the image. Finally, the true plate region is detected in the original image.

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The flowchart of the proposed CLPD method is shown in Fig. 1

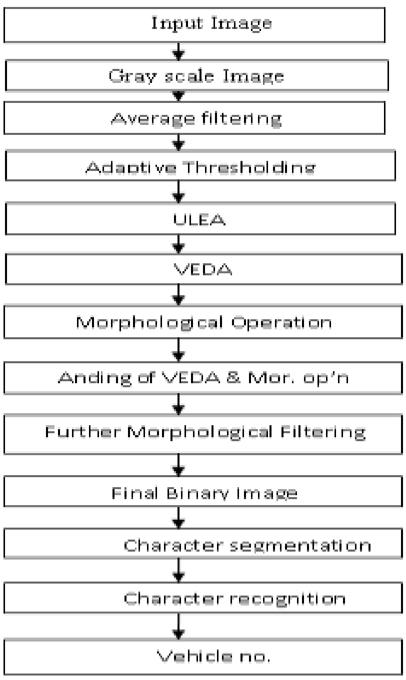


Fig 1. Flow diag. of VEDA method

1) Technique of AT:

Here the pixel is compared with an average of neighboring pixels. Specifically, an approximate moving average of the last *S* pixels seen is calculated while traversing the image. If the value of the current pixel is *T* percent lower than the average, then it is set to black; otherwise, it is set to white. This technique is useful because comparing a pixel to the average of neighboring pixels will keep hard contrast lines and ignore soft gradient changes. The advantage of this technique is that only a single pass through the image is required.

2) ULEA

Thresholding process in general produces many thin lines that do not belong to the LP region. Therefore, we have proposed an algorithm to eliminate them from the image. This step can be considered as a morphological operation and enhancement process. There are four cases in which unwanted lines can be formed. In the first case, the line is horizontal with an angle equal to 0◦ as (−). In the second case, the line is vertical with an angle equal to 90◦ as (|). In the third case, the line is inclined with an angle equal to 45◦ as (/). In the fourth case, the line is inclined with an angle equal to 135◦ Therefore, the ULEA has been proposed to eliminate these lines. A 3 × 3 mask is used throughout all image pixels. Only black pixel values in the thresholded image are tested. To retain the small details of the LP, only the lines whose widths equal to 1 pixel are checked. Suppose that $b(x, y)$ are the values for thresholded image. Once, the current pixel value located at the mask center is black, the eight-neighbor pixel values are tested. If two corresponding values are white together, then the current pixel is converted to a white value as a foreground pixel value (i.e., white pixel).

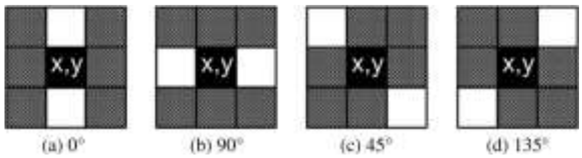


Fig. 2. Four cases for converting the center pixel to background. (a) Horizontal. (b) Vertical. (C) Right inclined. (d) Left inclined.

3) VEDA

The advantage of the VEDA is to distinguish the plate detail region, particularly the beginning and the end of each character. After thresholding and ULEA processes, the image will only have black and white regions, and the VEDA is processing these regions. The idea of the VEDA concentrates on intersections of black–white. A 2 × 4 mask is proposed for this process, as shown in Fig. where *x* and *y* represent rows and columns of the image, respectively. The center pixel of the mask is located at points (0, 1) and (1, 1). By moving the mask from left to right, the black–white regions will be found. Therefore, the last two black pixels will only be kept. Similarly, the first black pixel in the case of white–black regions will be kept.

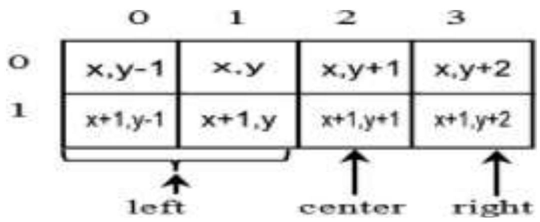


Fig: 3. Design of the proposed mask

Maximally stable Extremal Region method

The recognition of vehicle license plate is a important task in ITS. So features are extracted to detect and locate the plate region. A MSER license plate detection method is proposed by some prior knowledge of license plate. First the image is pre-processed with gray scaling and gray stretching, etc, and then, the candidate MSER(Maximally Stable Extremal Region) license plate regions are chosen according to the pixel sum, the scale and length-width ratio of the license plate character region, next, the similar single-character regions are removed and the lower and upper borders of the license plate are determined in this step, using the constraints of the gray level jump and horizontal projection of candidate license plate character region, finally, the left and right borders of license plate are determined by vertical projection.

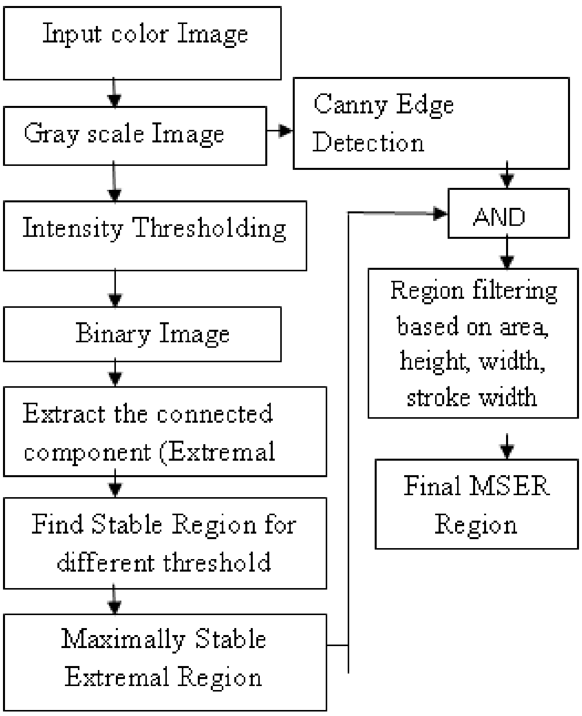


Fig. 4.Flow Diagram of MSER Method

1) Implementation of MSER:
-First of all sweep threshold of intensity from black to white performing a simple luminance thresholding of the image.
-Then extract the connected components (‘Extremal Regions’)
- Find a threshold when an extremal region is maximally stable.
- Finally we get the regions descriptors as features of MSER.

Image I is a mapping: ⊂ → these are the extremal regions defined on the image.
1. S is totally ordered that means it is reflective, anti-symmetric and transitive binary relation
<=exists. In this paper we consider = {0, 1,225}
2. An adjacency relation ⊂ ∗ is defined in this paper we used 4-neighbourhoods are used i.e. ∈ are adjacent ( ) $\mathcal{E}$ | − | ≤ 1.

2) Extraction of Text Regions

In this section we discuss about Extraction of text regions for this we have employed canny edge detection, region filtering and finally stroke width technique to extract text regions from MSER.
The proposed method is also sensitive to small letter, blur image, limited resolution image. The proposed enhanced MSER based method of text detection includes the following steps:

1. MSER region detection: Normally, text characters usually have consistent color. So we start to find the text by selecting the regions of similar intensities by using MSER region detector. Many non-text regions are also detected and so further processing is applied.

2. Intersection of canny edge with MSER region: Canny edge detection algorithm performs a high response to edge detection. And intersection of MSER and canny edge produce the region that is likely be text. By using the region properties, some connected component can be removed. According to the variation of different font, image size, or languages the filtering thresholds are automatically detected in our proposed algorithm.

3. Visualization of text candidate’s stroke width: Character in almost all language has a similar thickness throughout or stroke width. After this step the region where the stroke width contains too much variation is eliminated.

4. Text candidate after stroke width filtering: Non text region can be eliminated by determining a large variation in stroke width.

5. Image region under mask created by joining individual characters: Then the individual component is merged to compute a bounding box of text region. Morphological closing is done here.

License plate recognition system based on SIFT features

Scale invariant feature transform (SIFT) is an algorithm in machine vision, finding and describing local features of the image key points in order to recognize objects in given images. In this method, proper feature description of an object plays an important role for identifying and detecting a specific object in any image. Therefore, the set of features extracted from the training images must be robust to changes in image scale, noise and illumination in order to perform reliable recognition. So SIFT key points of objects are extracted from a set of reference images and stored in a database. In the next stage, the method transforms an image into a large collection of feature vectors which are invariant to image translation, rotation, scaling and partially invariant to illumination changes.

The SIFT algorithm takes an image and transforms it into a collection of local feature vectors. Each of these feature vectors is supposed to be distinctive and invariant to any scaling, rotation or translation of the image. In the original implementation, these features can be used to find distinctive objects in different images.

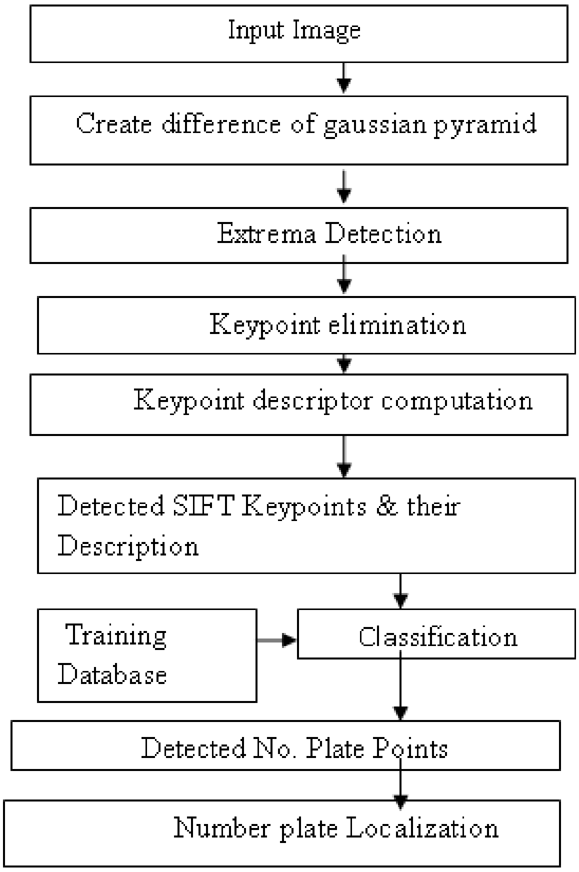


Fig: 5. Flow diagram of SIFT

1) Creating the Difference of Gaussian Pyramid

The first stage is to construct a Gaussian "scale space" function from the input image. This is formed by convolution (filtering) of the original image with Gaussian functions of varying widths. The difference of Gaussian (DoG), D(x, y, σ), is calculated as the difference between two filtered images, one with k multiplied by scale of the other.

$$D(x, y, \sigma) = L(x, y, k\sigma)-L(x, y, \sigma)$$

These images, L(x, y, σ), are produced from the convolution of Gaussian functions, G(x, y, kσ), with an input image, I(x, y).

$$L(x, y, \sigma) = G(x, y, \sigma)*I(x, y)$$

$$G(x, y, \sigma) = 1/2\pi\sigma^2 \exp \{- (x^2+y^2)/2\sigma^2\}$$

This is the approach we use in the implementation.

2) Extrema Detection

This stage is to find the extrema points in the DOG pyramid. To detect the local maxima and minima of D(x, y, σ), each point is compared with the pixels of all its 26 neighbor. If this value is the minimum or maximum this point is an extrema. We then improve the localization of the keypoint to sub pixel accuracy, by using a second order Taylor series expansion. This gives the true extrema location as:

$$Z = - (\partial^2 D/\partial x^2)^{-1} (\partial D/\partial x)$$

Where D and its derivatives are evaluated at the sample point and $x=(x, y, \sigma)^T$ is the offset from the sample point.

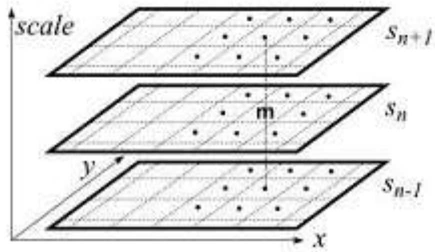


Fig. 6. An Extrema is defined as any value in the DoG is greater than all its neighbors in scale- space

3) Key points Elimination

This stage attempts to eliminate some points from the candidate list of keypoints by finding those that have low contrast or are poorly localized on an edge. The value of the keypoint in the DoG pyramid at the extrema is given by:

$$D (z) = D + (1/2)(\partial D^{-1}/\partial x) z$$

If the function value at z is below a threshold value this point is excluded

To eliminate poorly localized extrema we use the fact that in these cases there is a large principle curvature across the edge but a small curvature in the perpendicular direction in the difference of Gaussian function.

4) Descriptor Computation

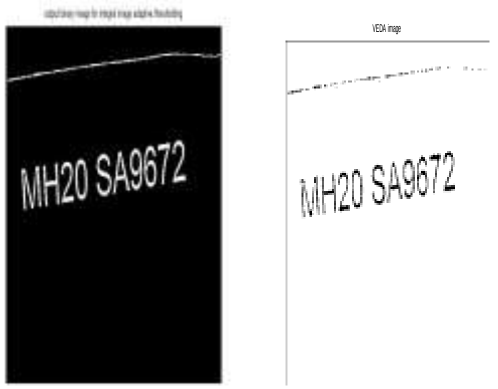
In this stage, a descriptor is computed for the local image region that is as distinctive as possible at each candidate keypoint. The image gradient magnitudes and orientations are sampled around the keypoint location. These values are illustrated with small arrows at each sample location on the first image of Figures. In our implementation, a 4x4 sample array is computed and a histogram with 8 bits is used. So a descriptor contains 4x4x8 elements in total.

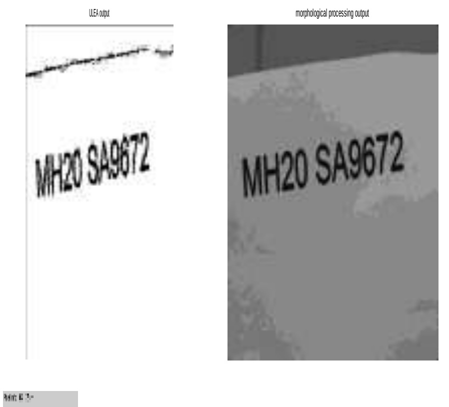
V. RESULT

Since for plate region extraction we are using three different methods, so we getting different output for all three but character segmentation and character recognition are same for all three methods.

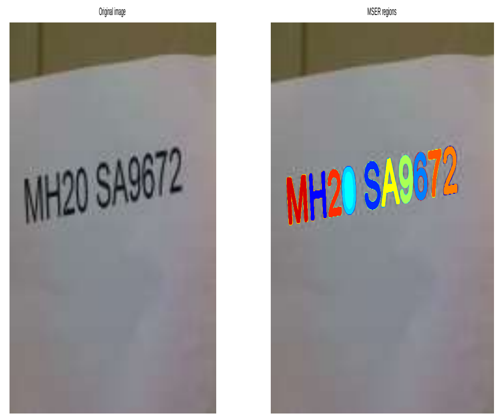
1) Result for plate region extraction

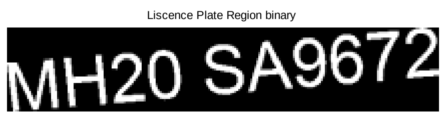
VEDA with morphological approach





MSER method



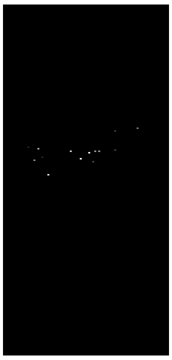


License plate recognition system based on SIFT features original image

Image with key points mapped onto it

matched keypts

binary image

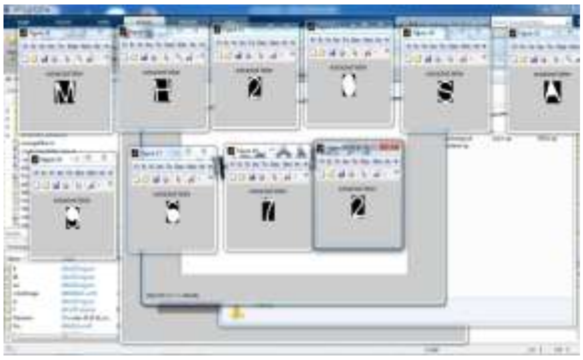


binary image after dilation

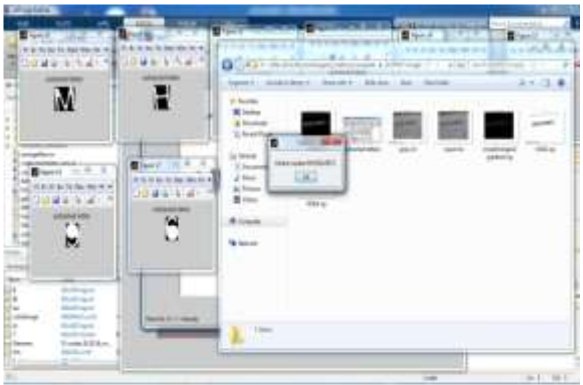
Plate image

Plate image binary

2) Result for character segmentation



3) Result for character recognition and display vehicle no.



VI. CONCLUSION

The VEDA contributes to make the whole proposed CLPD method faster. We have proposed a CLPD method in which data set is captured by using a web camera. Only one LP is considered in each sample for the whole experiments. In the experiment, the rate of correctly detected LPs is 91.4%. In addition, the computation time of the CLPD method is 47.7 ms, which meets the real-time requirements. Finally, the VEDA-based CLPD is good in terms of the computation time and the detection rate. This paper presented an enhanced MSER based scene text method. It is capable of differentiating the text part from the natural scene image and can recognize the text from the selected text region. To overcome the complexity of image blur and small letter, enhanced MSER has developed with complementary properties of MSER and Canny edge. The SIFT features described in our implementation are computed at the edges and they are invariant to image scaling, rotation, addition of noise. They are useful due to their distinctiveness, which enables the correct match for keypoints between images.

Pros and cons of each class of license plate extraction method

	Pros	cons
VEDA with morphological approach	1. Simplest, fast and straight forward. 2. Be able to detect tilted image.	1. Proper lighting needed. 2. Image should be properly focused.
MSER	1. No need to proper lighting.	1. Not able to detect tilted image because of average width and height function. 2. Not able to detect blur image or deformed license plate.
SIFT	1. scale invariance 2. most accurate keypoint detection method	1. Accuracy depends on the training data that is provided. 2. If training data is incorrect, accuracy decreases.

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