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A New and Efficient Method for Vehicle License Plate Detection

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Abstract— The Vehicle Licence plate Detection Method has many applications like cars parking in hotels, traffic signal violation, electronic toll collections and border crossing vehicle etc. Any detection method has some major challenges like Licences plates have arbitrary sizes, orientations, complex backgrounds and localization of licence plates. In this paper a new vehicle licence plate detection method is presented which is mainly based on localization of licence plate and recognition of characters. License Plate localization is the main challenge in the successful License plate recognition and an efficient method is employed for successful License plate extraction from the captured image. This paper presents the various steps of automatic plate localization of Cars License Plate Recognition system. In the proposed method recognition of character contains four parts which successfully recognize license plate. And finally, the proposed method is robust and efficient in all conditions.

Keywords— Automatic Number Plate Recognition (ANPR), License plate localization, Convolution matrices, Rank filtering, Thresholding, Dilation.

I. INTRODUCTION

Automatic Number Plate Recognition is an important stage in intellectual traffic systems. Nowadays vehicles play dynamic role in transportation. Also the use of vehicles has been increasing day by day because of population growth and human desires of vehicles. By the fast development of highway and the extensive use of vehicle, researchers start to pay more care on efficient and precise intelligent transportation systems. Automatic number plate recognition is a special set of hardware and software components that precedes an input graphical signal and recognizes license plate characters from it. This system has a wide range of applications, starting from parking access to vehicle management, as well as traffic control and public security.

The study of automatic vehicle license plate was initiated in 1990s [1]. The first license plate recognition method was based on Hough transformation in this firstly the 2D image was binaries after that Hough transformation apply to find straight lines in the image. By the use of parallel horizontal and vertical straight lines and their cutting points, we can find the number plate in the image [2, 3]. The texture approach of vehicle license plate detection was presented in [4], another localization of license plate detection method which was based on edge extraction [6]. The method based on edge extraction and texture is nearly invariant to different illumination conditions so they are widely used for plate detection. Colour image features based on the concept that all specific region have some definite colour of license plate, by the use of this idea the detection of license plate becomes easy [6]. Some license plate detection method was based on morphological operation like dilation, erosion skeletonization [5, 8]. Neural network learning based method was presented in [9].

License Plate Recognition generally has two phases: In the first phase, extraction operation of license plate from the captured image is performed and in the second phase, recognition of obtained characters is performed. There are a lot of problems in developing such a system such as requirement for real time processing, various illumination conditions and removal of different types of noises from the captured image. Localization (detection) is typically the critical problem, since some commercial systems for recognition of printed text are already available. Various works have been published under restrictive conditions, such as orientation of the text (plate), etc. There are three methods that have been described for automatic number plate detection based on morphological operations [3] but the region of interest have to be chosen manually. Another method has been proposed for an automatic text detection method for moving motor vehicles but it assumes that region of interest and the text direction is given by movement of vehicles [5]. Several works have been reported in context of partially illumination invariant detection method but the experiments include only images with closed look with high resolution of License Plate (Character height of about 50 pixels) and the view invariance is presented in a quite limited range [4]. In this paper, an efficient approach of license plate detection is developed and successful testing is being performed on a large number of samples. The proposed method is based on convolution matrix Prewitt and Sobel operator. Convolution of the function *f* with specific types of matrices to detect edges in an image. The equation of convolution matrix which is used in proposed method is given as follow:

$$f'(x,y) = f(x,y) * m[x,y] = \sum_{i=0}^{w-1} \sum_{j=0}^{h-1} f(x,y).m[mod_w(x-j), mod_k(y-j)]$$

Where w and h are dimensions of the image represented by the function f.

The convolution matrix defines how the specific pixel is affected by neighbouring pixels in the process of convolution. Individual cells in the matrix represent the neighbours related to the pixel situated in the centre of the matrix. The pixel represented by the cell y in the destination image is affected by the pixels x_0 ....x_8 according to the formula:

$$y= x_0*y_0+x_1*y_1.....+x_8*y_8.$$

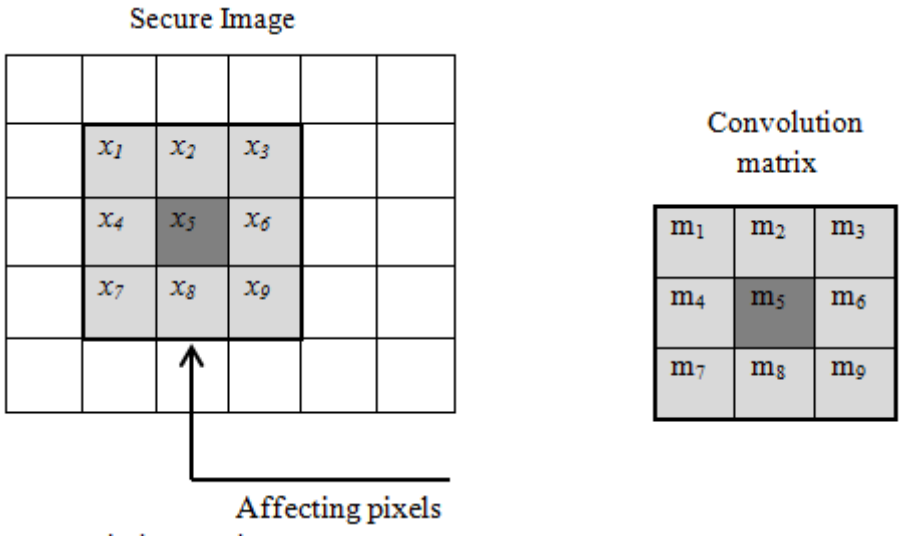


Figure 1. The pixel is affected by its neighbours.

This paper is organized in IV section. Section II explains various steps of proposed methodology. Experimental result is made in section III. Conclusions and future scopes are given in Section IV.

II. PROPOSED METHODOLOGY

Firstly an image of the license plate of the vehicle is captured and then this image is converted into grayscale. We define operations such as edge detection and region filtering as mathematical transformation of function f. The detection of Number plate area consists of a series of convolution operations. Modified snapshot is then projected into areas x and y. These projections are used to determine the area of a number plate. The step by step description of proposed method is given as follow:

Step 1: Firstly an image of the license plate of the vehicle is capture and then this image is converted into grayscale.

Step 2: In the vertical edge detection is performed in second step. The convolution matrix used in this work is given below:

$$m_{ve} = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

This matrix is used to detect the vertical edges in the image. Size of the convolution matrix is kept small otherwise longer edges which do not belongs to the license plate also get detected and detection of some characters becomes difficult.

Step 3: Removal of noise, the noise present in the image gets reduced using thresholding. The value chosen for thresholding during testing of the license plates is 126.

Step 4: Horizontal Rank Filtering, rank filtering is done to detect clusters of high density of bright edges in the area of the number plate.

Step 5: Detection of maximum horizontal line, the image is scanned until we get first white pixel (x_1, y_1) and the first black pixel (x_2, y_2). The length of maximum horizontal line is

$$\text{Maximum length} = x_2-x_1+1$$

Where $y_1= y_2= y$ line being horizontal.

Step 6: Horizontal Clipping, the horizontal range (Ystart to Yend) where the number plate resides is calculated as below:

$$Y_{start} = y- max1+1$$
$$Y_{end} = y + max2$$

Step 7: Now, a subsequent operation was performed in this region which leads to significant improvement in the efficiency of the program. Next step is to find vertical range for which the sub image is convolved using the horizontal edge detection matrix as shown below.

$$m_{he} = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

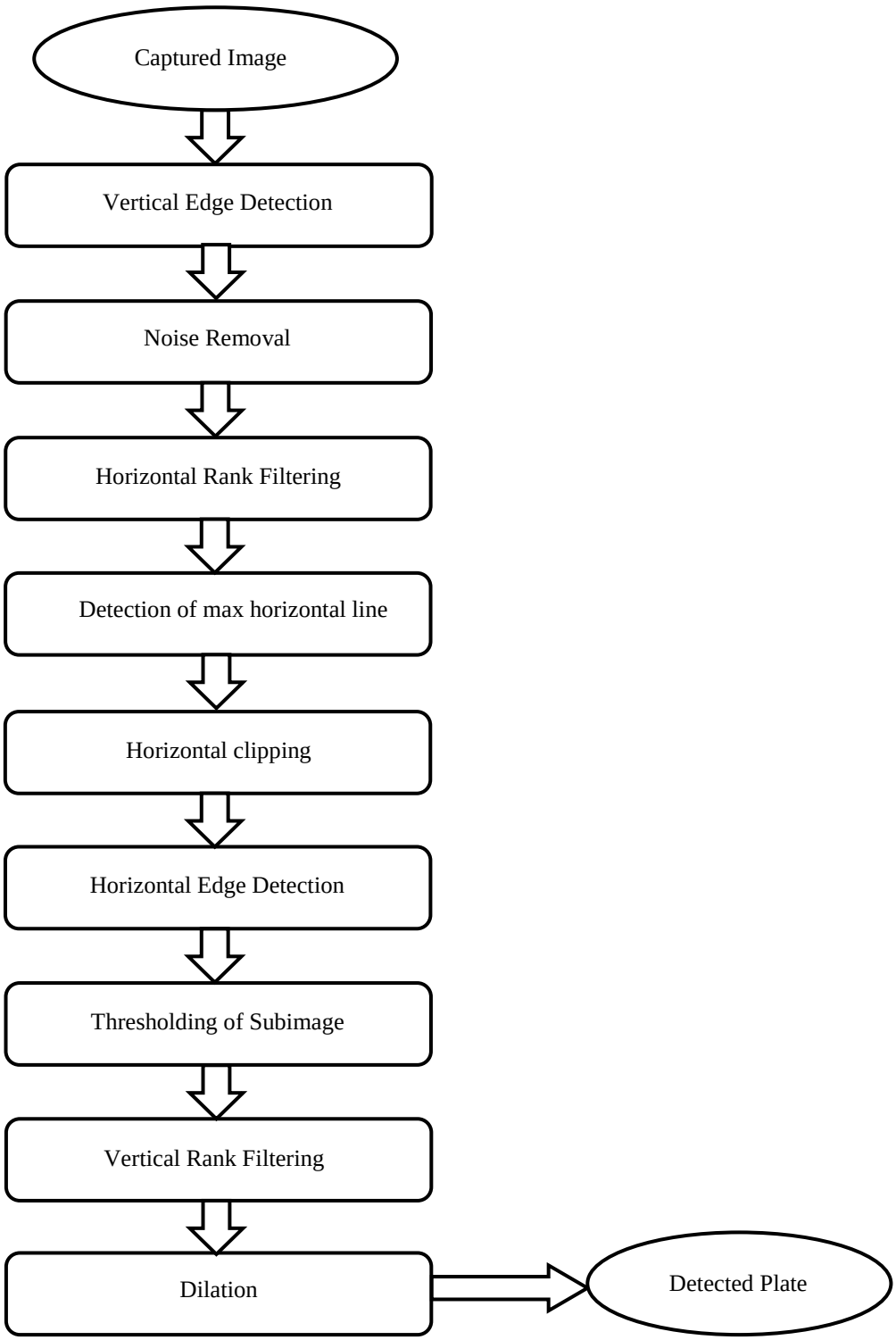


Figure 2. Flow Chart of Proposed Method.

Step 8: Thresholding of sub image and Vertical rank filtering, the sub image is thresholded at median pixel intensity 126. To completely extract the number plate we have to form the clusters around this region. This is achieved with the help of vertical rank filter of order (1, 9) matrix.

Step 9: To eliminate the region above and below the license plate, Dilation is applied using a suitable structuring element. Structuring element is decided according to the aspect ratio of the horizontal and vertical lines as the ratio of horizontal and vertical length of license plate are already defined by transport security control department.

Step 10: Detection of number plate, the coordinates of the region having number plate is calculated by vertical and horizontal range clipping and finally number plate is detected.

Step 11: After detection of number plate recognition of plate characters take place which basically contains four parts first is Segmentation of characters second is extraction of pieces third part covers skeletonization and thinning of characters fourth part is graph of characters and fifth is definition and recognition of characters.

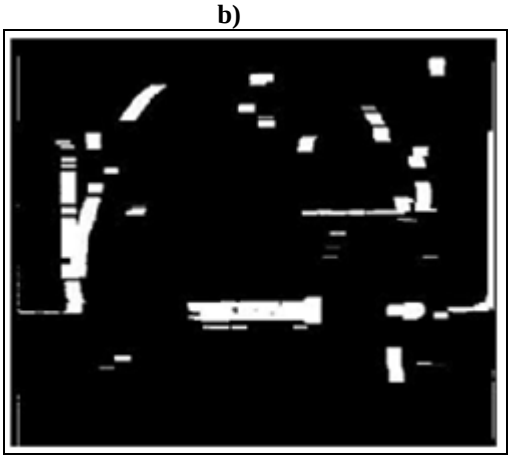
III. EXPERIMENTAL RESULTS

The experimental results parts cover the detection of vehicle licence plate from an image. After that recognition of plate takes place. The figure shown below give the complete description of experimental results.

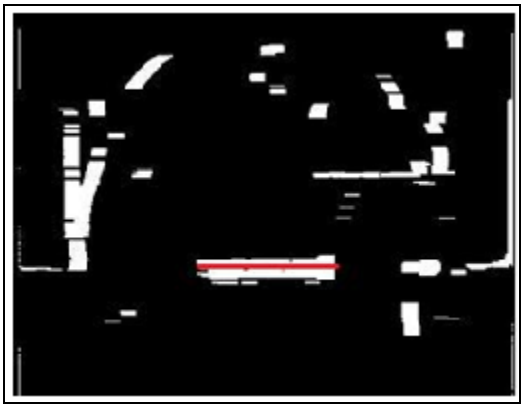
a)

b)

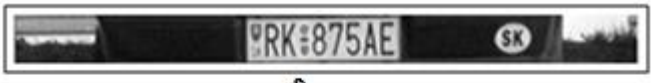
c)



d)



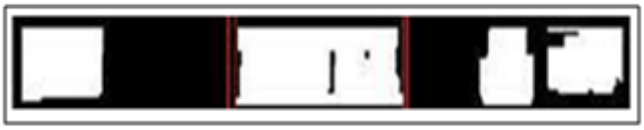
e)



f)

g)

h)



i)

j)

Figure 3. a) Condensed Original Image. b) Vertical Edges Detection . c) The Thresholded Image. d) The horizontal rank filtered image. e) Detection of maximum horizontal line f) Horizontal clipped image. g) Horizontal edge detection on sub image. h) The thresholded sub image. i) The horizontal rank filtered sub image. j) Detected number plate.

The figure above shows the detection of vehicle license plate after that license plate characters are identified. Experiments have been carried out on 500 samples out of which 490 number plates were detected successfully. This experiment shows that the proposed method is an efficient approach of license plate detection and successful testing is being performed on a large number of samples. Experiment shows that this new approach provides 98% of accuracy in detecting the license plate.

IV. CONCLUSION AND FUTURE SCOPE

The performance of presented method in this paper of License Plate Localization is found reasonable competing with existing class of algorithms. The newly developed method accurately localizes the license plates given as input. The method is tested on 500 samples and license plate was successfully detected in majority of the samples. The accuracy rate of the developed method is 98%. Tremendous efforts have been made to detect number plates of various vehicles and Automatic Number Plate Recognition (ANPR) system has been developed, still there are various scopes to improve the number plate detection by enhancing this method or developing new method. One of the biggest challenges is that the processor and the cameras must work fast enough to accommodate relative speeds of more than 160 km/h. Poor image resolution, usually because the plate is too far away but sometimes resulting from the use of a low-quality camera. Poor lighting and low contrast due to overexposure, reflection or shadows may create the problems to efficient license plate recognition system.

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