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Detection And Matching Of License Plate Using Veda And Correlation

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Abstract— This project proposes a fast method for detection and matching of license plate . Detection consist of vertical edge detection algorithm (VEDA) based on the contrast between the grayscale values, which enhances the speed of the license plate detection (LPD) method. After binarizing the image of input using adaptive thresholding (AT), an noise elimination algorithm (NEA) is proposed to enhance the image, and then, VEDA is applied. LPD method processes very-low-resolution images taken by a web camera. After the vertical edges had detected by the VEDA, the candidate region based on statistical and logical operations need to be extracted. Finally, an LP is detected from the image. In order to track a criminal, correlation analysis is performed after LP is detected and criminal's license plate is chosen as reference. In this project, two individual plates are taken and matching is done with respect to reference plate. The programming and simulation of the processes as well as the analysis of the results were done using MATLAB.

***Index Terms*— Adaptive thresholding (AT), license-plate detection (LPD), vertical edge detection algorithm (VEDA), noise elimination algorithm (NEA).**

I. INTRODUCTION

The license-plate (LP) recognition system is an image processing technology used to identify vehicles by capturing their LPs. The LP recognition technology is also known as automatic number-plate recognition, LP recognition, automatic vehicle identification or optical character recognition for cars [2]. The LP detection and recognition system (LPDRS) is an important area of research due to its various applications.

Image-Based vehicle recognition is categorized based on detection, classification, and identification. These had been adopted widely to various applications. The detection of vehicles is applied to occupancy management of parking areas, advisory of congestion, and surveillance of illegally parked vehicles. The classification is mainly for the electronic toll collection system (ETC) and to display available parking spaces to vehicles for easy parking. The identification is also employed for managing parking facilities, monitoring and analysis of traveling time, and security systems such as observation of stolen vehicles and monitoring of unauthorized vehicles entering private areas.

Usually, a LPDRS consists of three parts: license-plate detection (LPD), character segmentation, and character recognition. From these, the major part is to correct extraction of the license plate position, which will affect system's overall accuracy. There are many difficulties in license plate extraction process, such as lack of image quality from the uneven lighting condition, plate sizes and designs, processing time, background details and complexity various observation angles from the vehicles and cameras.

The requirement for car identification is become greater in amount because of crime prevention, border control, and vehicle access control. To find a car, need to consider the features like color, model, and LP number. In vehicle identification systems, cameras has been used and installed in front of police vehicles to identify those vehicles. Commonly vehicle identification and pursue systems use large resolution cameras, and this leads to large cost of the system in both hardware and software[3]. Usually, LPDRS is based on an image acquired at camera with resolution 640 × 480. An enrichment of LPD method performance such as reduction of algorithm complexity and, computation time or even the build of the LP identification system with minimum cost of its hardware devices, will make it more efficient and usable than before. This paper proposed a method for LPD, in which a web camera with 352 × 288 resolution is used rather than more practical web camera. Vertical edge extraction and detection is an main step in the LPDRS because it change the computation time and system's accuracy. Hence, a new vertical edge detection algorithm (VEDA) is introduced here to improve the efficiency of LPD method.

II. FEATURE EXTRACTION TECHNIQUE

The process is used to extract the features of a character. From this extracted features, it will be clustered into a group, which will make the recognition process easier and error free. Features are categorized in to four primary groups; structured feature, global transformation and template correlation and matching [4]. The features should be able to differentiate between characteristics. Feature extraction contributes for increasing recognition accuracy rate. Feature extraction is done on 3 types of image; grayscale, binary and vector .

Grayscale is a technique where the image is analyzed using original pixel value meanwhile binary is an approach to represent image in terms of black and white pixels which

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

belongs to contours or solid characters. In grayscale image, extraction is done through original pixel value whereas in the case of binary images, black and white pixels are used. Otherwise vector technique tries to deformed and reconstruct the character by using thinning process and calculates the straight lines and intersection points appearance and form character graph directly to represent its character uniqueness.

A. Feature Extraction Using Morphological Operations

Some morphological operations is used to find the high contrast area to detect license plates[5].

Let $S_{m,n}$ indicate a structuring element with size $m \times n$ where m and n are odd. Let $I(x,y)$ denote a gray-level input image. Besides, let $\oplus$ denote a dilation operation and $\odot$ denote an erosion operation. According to $S_{m,n}$, we define several useful morphological operations as follows:

Closing Operation:

$$I \bullet S_{m,n} = (I \oplus S_{m,n}) \odot S_{m,n} \quad (1)$$

Opening Operation:

$$I \circ S_{m,n} = (I \odot S_{m,n}) \oplus S_{m,n} \quad (2)$$

Smoothing Operation E:

$$\sum_{i=-n/2}^{i=n/2} \sum_{j=-m/2}^{j=m/2} I(x+i, y+j) s_{1\times m}(i,j) \quad (3)$$

To eliminate noises, first apply a smoothing operation with a $S_{m,n}$. Then, the closing I_c and opening I_o operations can be obtained by performing into the smoothen the image. To detect vertical edges, differencing operation is applied to the images Ic and Io. Thresholding is applied to extract all possible vertical edges. It is known the vertical edges in a license plate are close and adjacent to each other. These adjacent edges can be connected together through a closing operation and then form a connected segment. Therefore, before thresholding, a closing operation is applied first to let all adjacent vertical edges form a connected region. Then a labeling process is executed to extract the license plate-analogue segments. Then, a set of potential license plates can be obtained from a cluttered environment.

B. Feature Extraction Using Edge Extraction

License plate area contains large edge and texture data [6]. First image is need to extract out using image enhancement and edge detectors. Next is to remove most of the noise edges by an effective algorithm. There are so many edge detectors.

1. Robert operator
2. Sobel operator
3. Prewitt operator
4. Kirsch Edge detection
5. Canny Edge Detection

C. Feature Extraction Using Salience Theory

Target recognition needs to extract the features of the target. However, if all the features are used, many questions will appear, such as difficult operation, slow speed, and imprecise result . The task of feature selecting is how to find a set of salient features that are more effective in recognizing targets. The salient feature means what are advantageous to classifying objects. In mathematical expression, the salience feature represents the minimum probability of error in distinguishing a falsely object from the background. Therefore, the most salient feature corresponds to the largest probability in the extracting procedure. According to the prior information trained, in the actual recognition procedure, the system only extracts several salient features. This paper applies the minimum probability of error as the rule of feature selection [7].

Target recognition finds a method to improve the separability of targets and backgrounds. The separability is defined as making the probability of false Pf become the smallest .

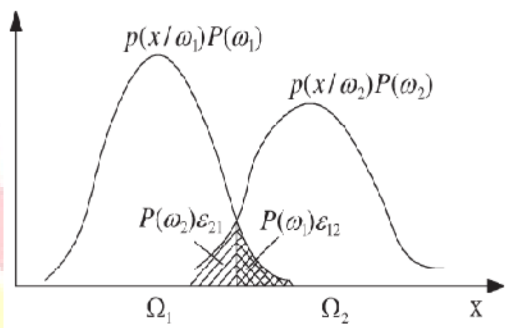

Fig. 1: P_f of the 1-D pattern computation sketch map

As for target recognition, Pf is hoped to become statistically least, i.e.,

$$P_f = \int_{\Omega 1} P(w_2)\, p\left(\frac{x}{w_2}\right) dx + \int_{\Omega 2} P(w_1)\, p\left(\frac{x}{w_1}\right) dx \rightarrow min \quad (4)$$

where $P(\omega 1)$ and $P(\omega 2)$ are the prior probabilities of $\omega 1$ and $\omega 2$, respectively, and $P(x/\omega 1)$ and $P(x/\omega 2)$ are the probability density functions of $\omega 1$ and $\omega 2$, respectively. This is the minimum probability of error criterion. When Pf is minimum, the corresponding feature is defined as the most salient feature.

III. PROPOSED METHOD

The block diagram of the proposed method is shown in Figure.2. In this paper, the color input image is converted to a grayscale image, has the values between [0-255], and then, adaptive thresholding (AT) is applied on the image to create the binarized image. After that, the NEA is applied to remove noise and to boost the binarized image. Next, the vertical edges are extracted by using the VEDA. The next process is to detect the LP. Then, some statistical and logical operations are used to detect candidate regions and to select for the true candidate region. Finally, the true plate region is detected in the original image.

This paper has three contributions:

- The VEDA is proposed and used for detecting vertical edges
- The proposed LPD method uses low-quality images produced by a web camera with resolution of 352 × 288 with 30 fps; and

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

- The computation time of the CLPD method is less than several methods.

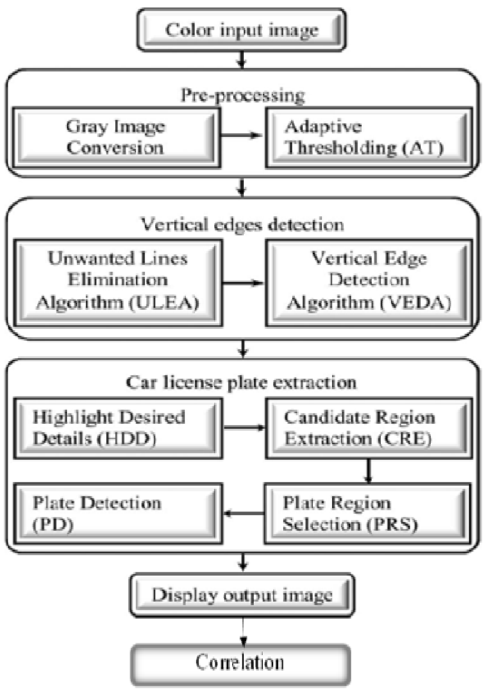

Fig. 2 : Block Diagram of the Proposed System

A. *Adaptive Thresholding*

First, take pixel values for every column *j*th through all row values *i* and compute the summation using

$$\text{sum}(I) = \left|\sum_{x=0}^{i} g(x,y)\right|_{y=j^{th}} \qquad (5)$$

Where $g(x, y)$ represents the input values, and sum(i)| jth represents all gray values of $g(x, y)$ for the column jth through all rows of image $I = 0, 1, . . .$ height.

Then, the integral image can then be computed for every pixel as in (6):

Integral Img(I,j)=

$$\begin{cases} sum(i), & if\ j = 0 \\ integral\ Img(i, j-1) + sum(i), & otherwise \end{cases} \qquad (6)$$

Where Integral Img(i, j) indicates the integral image for pixel (i, j). Then need to perform thresholding for each pixel. For that intensity summation for each local window is computed by using one addition operation and two subtraction operations as follows:

$$sum_{window} = (\text{Integral Img}(i+s/2,j+s/2) - \text{Integral Img}(i+s/2,j-s/2) - \text{Integral Img}(i-s/2,j+s/2) - \text{Integral Img}(i-s/2,j-s/2)) \qquad (7)$$

Where sum_{window} represents the intensity summation of the gray values for a certain local window, in which the currently binarized pixel is centering in.

The window boundary can be represented by

(i+s/2,j+s/2), (i+s/2,j+s/2),

(i+s/2,j+s/2), (i+s/2,j+s/2)

and s represents the local window size or lengths for the computed Integral Img, whereas s = image width/8. To compute the AT value for the image, in which $g(i, j)$ □ [0,255] is the intensity of the pixel located at (i, j).

Threshold $t(i, j)$ for each pixel has to be computed first as follows:

$$t(I,j) = (1 - T)\times sum_{window} \qquad (8)$$

The threshold for each pixel at location (i, j), is represented by $t(i, j)$ and $T = 0.15$ where T is a constant. This gives the correct value for efficient thresholding performance for the total images after testing on several images. The criterion is applied on each and every pixel to get output threshold value :

$$O(i,j) = \begin{cases} 0, & g(i,j)\times S^2 < t(i,j) \\ 255, & atherwise \end{cases} \qquad (9)$$

Where $o(i, j)$ represents the output adaptive threshold value of pixel $g(i, j)$, and S^2 represents the local window area for the selected region.

The affect of decrement of T value below 0.15 will cause new black regions, and increment of T above 0.15 will cause elimination of important details. Figure 3(a) shows the input image, and the result is shown in Figure 3(b) after AT is applied.

(a) (b)

Figure 3 : Image binarization. (a) Input image. (b) Thresholded image.

B. *NEA*

Thresholding process may produces many thin lines that do not belong to the LP region. In Figure 4 (b), we can see that there are many long lines and random noise edges in LP region. These noise edges are unwanted lines, these lines will interfere in the LP location. Therefore, we need to eliminate them from the image. This step is for image enhancement process by using morphological operation.

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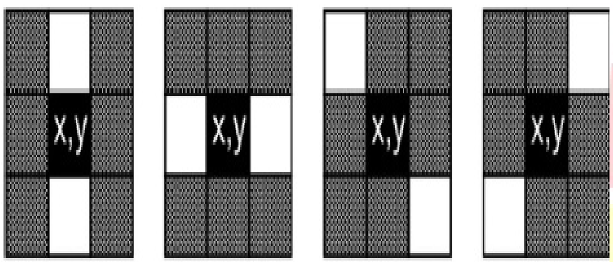
International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

There are mainly four cases in which unwanted lines or noises can be formed. The first case is horizontal line or angle with 0◦ as (−). In the second case, the vertical line or with an angle equal to 90◦ (|). The line is inclined with an angle equal to 45◦ as (/) in third case and the line is inclined with an angle equal to 135◦ as (\) in fourth case. Therefore, the NEA has been proposed to eliminate unwanted lines. When processing a binary image, keep the black pixel values as the background, and the white pixel values as the foreground. A 3 × 3 mask is used for all image pixels. It checks only black pixel values in the thresholded image. For retain small details of the LP, only the lines whose widths equal to 1 pixel are consider. Suppose that b(x, y) are the values for thresholded image. If current pixel value located at the mask center is black, then checks eight-neighbor pixel values.



(a)0^0 (b)90^0 (c)45^0 (d)135^0

Fig. 4: Four cases for converting the center pixel to background (a) Horizontal. (b) Vertical. (c) Right inclined. (d) Left inclined.

The possible case in which the current pixel is converted to foreground pixel is shows in Figure 4 (a)–(d). It represents values at each time that the mask moves through the image. Figure 5 shows the output after the NEA is performed, whereby many unwanted lines and noises are removed from the image.

Fig. 5 : (a) Thresholded image (b) NEA output

C. VEDA

It is used to find the beginning and the end of each character in license plate. By using this license plate can easily detected and character recognition process can be done faster. After thresholding and NEA processes, the image will have only black and white regions. The VEDA is processing in these black and white regions. The concept of the VEDA applies on intersections of black–white and white–black shows in Figure6 (a) and (b). For this 2 × 4 mask is used for this process, as shown in Fig. 3.6, in this *x* and *y* indicate rows and columns of the image, respectively. The mask is located at center pixel points (0, 1) and (1, 1). When the mask is moving from left to right, it checks whether the black–white regions will be there or not. If it is found, the last two black pixels will only be stored. Correspondingly, the first black pixel in the white–black regions will be stored.

Fig. 6 : Intersection of black–white and white–black regions.

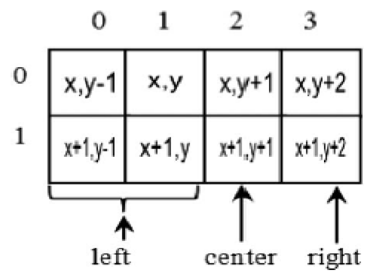


Fig. 7 : Design of the VEDA mask.

A 2 × 4 mask is used to perform VEDA operation. This mask is divided into three sub masks. The first “2× 2,” sub mask is the left mask, the second “2 × 1,” sub mask is the center mask and the third “2×1,” sub mask is the right mask as marked in Fig. 3.6. Here each two pixels has been checked at once, so the sub mask detect 2 pixel width. This process is used to detect the vertical edges by intersections of black–white regions. Equalently, the third sub mask is tested on the intersections of white–black regions. It will detect vertical edge with 1 pixel width. The number “2” points out the number of rows that are checked at once. The time consumption is less in this case compared to row is individually checked. After applying VEDA the result is shown in Figure 8.

Fig. 8 : VEDA Image

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

D. CRE

Candidate region extraction process is divided into four steps as follows.

1) Count the lines per each row:

The lines is drawn for each raw then count and keep in matrix variable How Many Lines[a], where a = 0, 1. . . height-1.

2) Divide the Image into different groups:

The large number of rows cause delay in processing time. To reduce the time consumption, collecting various rows as a group. For dividing the image into multi groups is done by the equation:

$$\text{How many groups} = \frac{\text{height}}{C} \quad (10)$$

Where how many groups represents the total number of groups, height represents the total number of image rows, and C indicates the candidate region extraction (CRE) constant. Here, $C = 10$, is chosen to represent one group. This will save the computation time and avoid loosing much desired details

Figure 9 shows an example for the total number of lines versus each group for the image. Here the total number of image rows is equal to 288, and the total number of groups is equal to 29 groups.

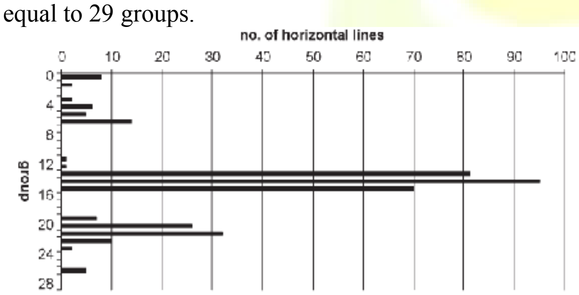


Fig. 9 : Number of horizontal lines versus group.

3) Count and store satisfied group indexes and boundaries:

Some of the group lines are not region of the plate details. So need to use a threshold to eliminate unsatisfied groups and to store the satisfied groups. In this paper threshold is set as 15. Each group will be checked; if it has at least 15 lines, then it is taken as a part of the LP region. Thus, the total number of groups including the parts of LP regions will be counted and stored.

4) Select boundaries of candidate regions:

This step has been drawn the horizontal boundaries above and below each and every candidate region. Figure 10 shows the result of candidate regions boundaries in the input image. As shown, here two candidate is found from horizontal-line plotting.

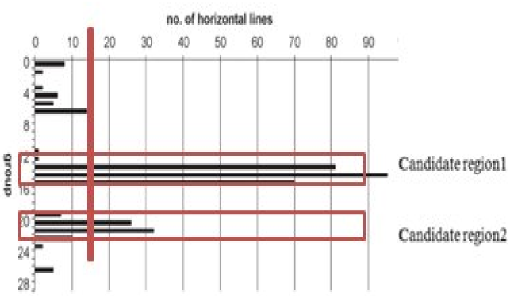


Fig. 10 : Output of the boundaries of drawing candidate regions.

3.1.5. PRS

Plate region selection process is mainly for selecting and extracting one correct LP. The process is discussed the selection process of the LP region. The flowchart of plate region selection (PRS) is shown in Figure 12.

1) Selection process of the LP region:

Some of the LP images are not clear, or the LP region might be defected. The LP region is need to be check pixel by pixel, for getting correct LP. A mathematical formulation is proposed for this purpose, and once this formulation is applied on each pixel, the probability of the pixel being an element of the LP can be decided.

In candidate regions, each column will be checked one by one. If the column blackness ratio exceeds 50%, then assume current column belongs to the LP region; then, this column will be replaced by a vertical black line in the image (Figure 11) .

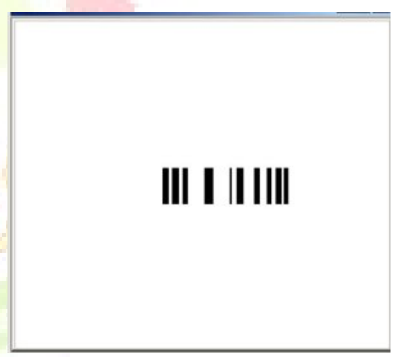


Fig. 11 : LP region replaced to vertical lines

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

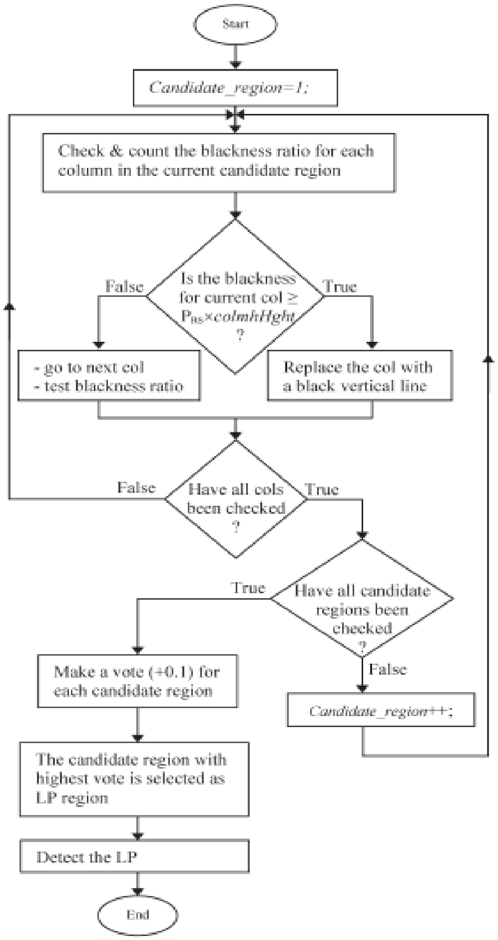


Fig. 12 : Flow chart of prs

Hence, each column is checked by the condition that, if blckPix ≥ 0.5 × colmnHght, then the current column is an element of the LP region. Here, the blckPix represents the total number of black pixels per each column in the current candidate region, and the colmnHght represents the column height of the of the candidate region. This condition with a fixed value (0.5) is used with nonblurry images. However, some pixels of the candidate regions will not be detected in case the ratio of blackness to the total length (height) of the candidate region is greater than 50%. Therefore, the condition is changed to be less than 50%, according to the ratio of the blurry level or the deformation of the LP. The condition will be modified as follows. blckPix ≥ *P*RS × colmnHght, where *P*RS represents the PRS factor. The *P*RS value is reduced when the blurry level is high to highlight more important details, and it is increased when the blurry level is less. Therefore, the mathematical representation for selecting the LP region can be formulated as follows:

$$C_{region} = \begin{cases} 0, & black\ pix \geq P_{ss} \times column\ Hght \\ 255, & otherwise \end{cases} \qquad (11)$$

where C_{region} represents the output value for the current pixel of the currently processed candidate region. If C_{region} = 0, consider the checked pixel as an element of the LP region; otherwise, consider it as background.

Making a Vote:

The columns whose top and bottom neighbors have high ratios of blackness details are given one vote. This process is done for all candidate regions. The candidate region can have the highest vote values will be the selected region as the true LP. The boundaries of the plate area are detected.

Fig. 13: Plate Region Of Image

E. *Correlation*

Image correlation analysis is done by using a criminal's license plate as reference one. For this analysis first of all individual license plates are captured through optical devices like cctv cameras. Then matching is done with reference plate. This is done pixel by pixel and it is interesting to note that correlation/matching can be easily in MATLAB.

These are the steps for checking

- Applying edge detection on pictures so that we obtain white and black points and edges of the objects (prewit).
- Count the black and white points in the reference picture.
- Comparing the edge points in the two input pictures with reference picture
- Calculating percentage matching

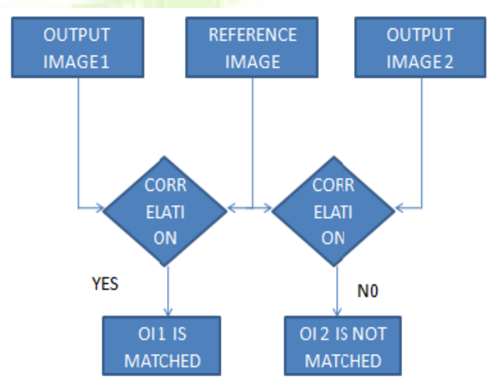


Fig. 14: Diagram of correlation

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

IV. RESULTS ANALYSIS

The proposed method is tested on MATLAB R2011a, to justify the effectiveness of the proposed algorithm with various input images. In this project from two license plates, criminal's license plate have to be identified. Firstly criminals license plate is extracted. Individual license plates are taken and extracted then correlation analysis is performed. Finally individual plate that is matched with criminal's license plate is found.

A. Reference Picture

Figure 14 and 15 shows the Reference image and plate region respectively.

Fig. 14 : Reference image

Fig. 15: Plate Region Of Reference Image

B. Individual Image 1

Same process is repeated for 2 individual images

Fig. 16: Input image I

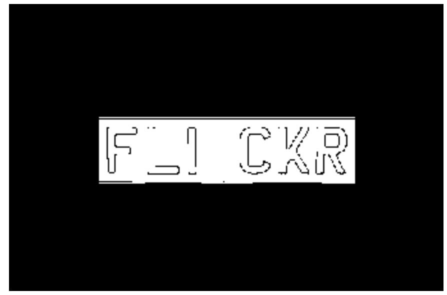


Fig. 17: Plate region of input image1

C. Individual Image 2

Fig. 18: Input image 2

Fig. 19: Plate Region Of Input Image 2

D. Correlation

In our analysis, reference image is matched with individual image 2. So it is displayed as Output_Message2 = Picture 2 Have Been Matched

V. CONCLUSION

License plate detection and matching is presented in this project, which is based on the vertical edge detection algorithm (VEDA) and correlation. Before VEDA was applied, NEA was done in order to enhance the binarized image. This enhancement process makes VEDA works faster than other methods. Even though accuracy of edge detection is nearly similar, experimental results demonstrated that VEDA is faster than other operator for extracting vertical edges. Our proposed approach has the advantage that it is able to work with motion blurred images for detecting the vertical

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 2, May 2015

edges. The advantage of VEDA is that this algorithm gives two pixel width for black-white region edges and one pixel width for the white-black region edges. This advantage makes it suitable for real-time processing. It also helps to detect plate details easily and faster during next processing steps. The algorithm gives good results, and it works in the situation where variations of the lighting conditions and different kinds of vehicle. It take short time to use this method in practice to recognize license plate. This automatic LP extraction system and matching of license plate helps official authority to find the vehicles of criminals.

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