

Algorithm for License Plate Localization and Recognition for Tanzania Car Plate Numbers

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Abstract: In this paper, License plate localization and recognition (LPLR) is presented. It uses image processing and character recognition technology in order to identify the license number plates of the vehicles automatically. This system is considerable interest because of its good application in traffic monitoring systems, surveillance devices and all kind of intelligent transport system. The objective of this work is to design algorithm for License Plate Localization and Recognition (LPLR) of Tanzanian License Plates. The plate numbers used are standard ones with black and yellow or black and white colors. Also, the letters and numbers are placed in the same row (identical vertical levels), resulting in frequent changes in the horizontal intensity. Due to that, the horizontal changes of the intensity have been easily detected, since the rows that contain the number plates are expected to exhibit many sharp variations. Hence, the edge finding method is exploited to find the location of the plate. To increase readability of the plate number, part of the image was enhanced, noise removal and smoothing median filter is used due to easy development. The algorithm described in this paper is implemented using MATLAB 7.11.0(R2010b).

Keywords: Image processing, License plate localization and recognition, Plate numbers, MATLAB.

1. Introduction

There is a need for intelligent traffic management systems in order to cope with the constantly increasing traffic on today's roads. Video based traffic surveillance is an important part of such systems [1][2]. Information about current situations can be automatically extracted by image processing algorithms. Beside vehicle detection and tracking, identification via license plate recognition is important for a variety of applications. These include, e.g. automatic congestion charge systems, access control, tracing of stolen cars, or identification of dangerous drivers.

Automatic License Plate Recognition systems are very popular and studied all over the world. It has been categorized in two main parts; finding license plates in images (Plate Localization), reading text from license plates. The some problems about images with license plates like poor image resolution, the plates is too far away, low quality camera, motion blur, poor lighting and low contrast due to overexposure, reflection or shadows, dirt on the plate. Image enhancement technique is very crucial based on filters to remove noise and unwanted effects of the light in order to obtain clear and readable images, are used.

Generally, a license plate localization and recognition (LPLR) system is made up of five parts; Image acquisition, pre-processing of image, plate extraction, character segmentation and character recognition (Figure.1)

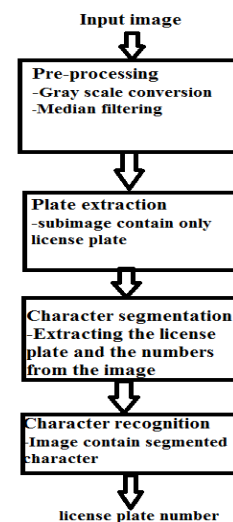


Figure 1: Proposed algorithm for a license plate localization and recognition (LPLR) system

In the developing countries like Tanzania the attributes of the license plates are strictly maintained. For example, the size of the plate, color of the plate, font face/ size/ color of each character, spacing between subsequent characters, the number of lines in the license plate, script etc. are maintained very specifically. Some of the images of standard license plates, used in Tanzania, are shown in Fig 2.



Figure 2: Standard license plates used in Tanzania.

There several researches have been done concerning license plate localization and recognition system. For example, Kim, S. et al [3] proposed a method based on edge extraction for license plate localization in images taken in poor lighting conditions. It consists of two steps. The first step involves the search of candidate regions from the input image using gradient information and the second step determines the plate area among candidates and adjusting the boundary of the area by introducing a plate template. On the other hand, Sarfraz, M. et al [4] utilized vertical edge detection and filtering which is then followed by vertical edge matching in the localization of Saudi Arabian license plates. As it is observed that images have more horizontal lines than vertical lines, this approach reduces computation time by detecting only vertical lines. In [5] and [6], additional edge extraction based approaches are discussed.

In the case of morphological based approaches, Dubey, P. [7] has improved morphological based approaches by modifying the conventional approach to yield a cleaner result on complex images by applying heuristics. Alternatively, Wu, C. et al [8] combine morphological operations and a projection searching algorithm for vehicles in Macao. The projection searching algorithm is used to detect region of the characters in the license plate through vertical and horizontal projections.

2. Methodology

The proposed system is designed to recognize the license plate from the front end and rear end of the vehicle. The input to the system is the image of the vehicle acquired by a digital camera and the output of the system is the localization and recognition of the extracted license plate. The implementation of the program is developed on MATLAB 7.11.0(R2010b). The following are the methods used during implementation of the system.

- Pre-processing
- Plate extraction
- Character Segmentation
- Character recognition

2.1 Pre-processing

The input image consists of many colors and the image is processed initially to improve the quality and prepares it to next phases of the system. Since the image has different colors the system will convert the RGB images to gray scale images using NTSC standard method.

$$\text{Gray} = 0.299 * \text{Red} + 0.587 * \text{Green} + 0.114 * \text{Blue}$$

In the next phase the gray image is filtered using median filter in order to remove the noise, while preserving the sharpness of the image. The filter used is a non-linear filter where it replaces each pixel with a value obtained by computing the median of values of pixels.

2.2 Plate extraction

The plate extraction is the second phase and the most important phase of the recognition system. In this each phase performs a process of segmentation on the gray scaled image to eliminate the pixels which does not belong to the license plate region. Let us consider an example that the horizontal

localization phase is responsible for detecting the horizontal segments that contain the number plate. In the same way vertical localization phase is responsible for locating the vertical segments of the number plate. Let us consider that we are taking into consideration of Tanzania number plates.

Two types of plates are available

- Black characters on yellow background
- Black characters on white background

This is just a consideration to explain the meaning of the edges in the image, for example if we take a license plate consist of a row of white characters on black background, we can say that the license plate is characterized by a row of transitions from black to white and vice versa, these transitions are called edges.

In this paper we used Sobel operators to find the edged image. The sobel command performs a 2 dimensional spatial gradient measurement on an image. Normally sobel operator is used to find the approximate absolute gradient magnitude at each point in an input image which is the gray scale image. The actual sobel masks are shown below.

If we define A as the gray scale source image, and G_x and G_y are two images which at each point contain the horizontal and vertical derivative approximations, the computations are shown in equations (1) and (2) for horizontal and vertical gradient window, respectively.

$$G_x = \begin{pmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} * A \quad (1)$$

$$G_y = \begin{pmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{pmatrix} * A \quad (2)$$

Then the magnitude of the gradient is calculated using the equation (3) below.

$$|G| = \sqrt{G_x^2 + G_y^2} \quad (3)$$

An approximate magnitude can be calculated using equation (4).

$$|G| = |G_x| + |G_y| \quad (4)$$

If A is denoted as the pixel values as in equation (3); the gradient value is shown in equation (4).

$$|G| = |(p1 - p7) + 2X(p2 - p8) + (p3 - p9)| + |(p1 - p3) + 2X(p4 - p6) + (p7 - p9)| \quad (5)$$

2.3 Segmentation

It is the process of extracting the license plate and the numbers from the image taken. There are different aspects that make that make this concept little complicated like noise in the image, frame of the plate, plate orientation, light intensity and space marks. Many systems have been proposed to overcome these problems. The method that is suggested in this thesis after result of the proposed system is

- 1) Pre-processing which includes
 - Converting image to gray scale
 - Binarization

- 2) Object enhancement algorithm

The object enhancement algorithm consists of two steps.

- Firstly, gray level of all pixels is scaled into the range of 0 to 100 and compared with the original range 0 to 255; the character pixels and the background pixels are both weakened.
- Secondly, sorting all pixels by gray level in descending order and multiply the gray level of the top 20% pixels by 2.55. Then most characters pixels are enhanced while background pixels keep weakened.

3) After preprocessing and object enhanced algorithm Horizontal segmentation is done and vertical bounds are noted to segment the characters on the number plate of the image.

3. Results and discussion

To test the proposed system experiments have been performed. The simulation process is carried out in MATLAB 7.11.0(R2010b) for the license plate localization and recognition. A set of 50 images were used for testing the proposed system. The images were taken from various environments. They are of different sizes and different colors. The plates were taken from complex images which contain different colors and several objects in the image. The images are taken from different inclined angles and distances relative to camera.

One example which is successful for coloured method is given below the normal image is fed to the software to get the gray image where numbers or letters can be identified then license plate number is located and extracted.

3.1 How Matlab codes work

First, the image is read from the directory with *imread* command; MATLAB stores the pixel values by 480 x 640 x 3 uint8 matrix. For the MATLAB implementation the resolution of the used images are 480 x 640. Since the algorithm depends on the intensity change in the image, binary image is needed. Binary image is generated by converting image to the gray scale first and then applying edge detection function. As a second step, with *rgb2gray* function; a new matrix 480 x 640 x 1 uint8 size is generated by taking the average of Red, Green, Blue pixel values. Then, for sobel edge detection *edge (image, sobel)* command is used. An intensity_change matrix is formed with size 480 x 1 by using the edge image. This matrix indicates the number of intensity change in a row; that is to say, the value of matrix for each row is increased when the side by side three pixel values are 0, 1, 0 or 1, 0, 1. For the next step, maximum value and the maximum index of the intensity_change matrix is found by *max* command. The maximum value is divided by two and taking maximum index as the middle, 81 row of matrix is compared with the half of maximum value. The adjacent rows greater than half value are the candidates of plate located rows. The height of the plate is calculated as approximately five times the difference of maximum row and minimum row. For the column location of numbered plate, this proportion is checked. While minimum and maximum column location greater than the proportion, the algorithm searches on the rows 1, 0, 1 sequence both from right and left side.

3.2 MATLAB Results

The following figures were taken from MATLAB result report. Fig 4 (a) shows the original image and (b) the gray scale image.



Figure 4 (a)



Figure 4 (b)

Fig 5 (a) shows the sobel edge detected binary image and (b) the intensity change of the rows. The sobel edge detection threshold is used as MATLAB default.



Figure 5 (a)

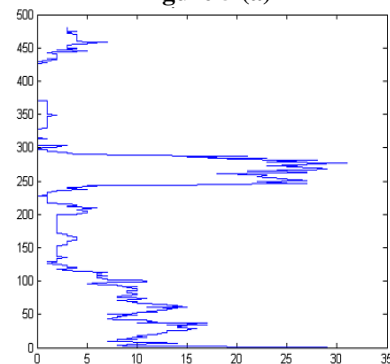


Figure 5 (b)

Fig 6 (a) shows the result of calculation of the rows which have greater value than half of maximum value of intensity variation and (b) the plate location on the image. The row and column location of the numbered plate is found.



Figure 6 (a)

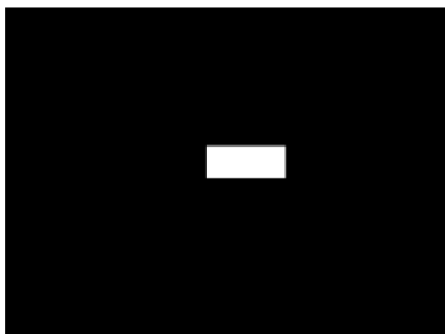


Figure 6 (b)

Finally, the result of the whole algorithm is shown in Fig 7.



Fig 7

4. Conclusion

In this present work, we have developed an effective method for localization of license plate regions from video snapshots of registered vehicles. The technique is extensively tested with 50 image samples and the gives satisfactory performance. The main distinctive feature of the plate, i.e. high contrast variation, is used to detect the location of the plate on the image. Then, noise removal and smoothing methods are used to enhance the visual quality of the plate region on the image. The applied algorithm was tested with static images and video streams both in MATLAB. For image processing algorithms, digital filters are used. First image processing part is plate localization. For plate localization, horizontal changes of the intensity, since the rows that contain the number plate are expected to exhibit many sharp variations, is calculated and summed. The sums that have maximum values are considered as plate areas. To find the high contrast areas, edges on the images, a band pass filter with finite response is used. The reason for using finite response filter instead of infinite is the fast execution time.

The further development assumes also adding new functionality, such as enhancement of the whole image or extracting plate characters from the image.

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