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Number Plate Recognition System Based on an Improved Segmentation Method

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Abstract: Number Plate Recognition (NPR) is a group surveillance system that captures vehicle photos and differentiates license numbers. NPR can help in the discovery of stolen cars. On highways, NPR systems can efficiently detect stolen vehicles. This study primarily introduces a novel and active method for detecting and recognizing license number plates, as well as obtaining photos of automobiles from a reliable source. The license plate number recognition system is divided into two stages: the first is license number plate localization, which uses localization algorithms to reveal the license number from the entire image; the second is the recognition phase, which analyzes the vehicle number plate obtained and then uses the template matching style. Finally, to assess the effectiveness of the proposed technique, a set of 300 composite photos with vehicle plates from various countries are used to test localization accuracy. The localization of license plates was completed with 99.7% accuracy and a processing time of 0.21 seconds.

Keywords: Pre-processing ; location of the number plate ;segmentation of character ; recognition of character.

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1. Introduction

In image observance and process systems, the vehicle's License and Number Plate Recognition (LNPR) system is a highly crucial space of analytical interest [1]. With the introduction of advanced cameras, the variety plate recognition system (LNPR) has a wide range of applications for traffic management, including car parking [2, 3], border crossing management [4], identification of stolen vehicles [5, automatic parking attendant [6], red light-weight camera [7], and so forth. Control and enforcement of speed limits at gas stations, as well as security. The majority of the core technique algorithms remain consistent in many of these applications. The LNPR system is divided into three parts: the first is the capture and detection of the vehicle's image, the second is the localization and extraction of the number plate from a detected image, and the third is the use of image segmentation techniques to recognize individual characters and optical character recognition (OCR) to recognize individual characters using a database stored for each and every list character [5, 8, 9]. The major detection hardware for the first half includes some cameras put in places of interest for intersection management, traffic observing [10, 11], and other purposes.

The remainder of the paper is laid out as follows. The second section gives an overview of previous research on vehicle number plate detection and recognition. Section 3 describes the suggested method for detecting and recognizing vehicle license plates. Performance in Simulation The results are shown in Section 4. The paper comes to a close with Section 5.

2. Related works

In particular, Christos Nikolaos [12] devised a method known as a sliding concentric window (SCW) for detecting Regions of Interest more quickly (ROI). Two coaxial windows move from the image's upper left corner in this technique methodology. Statistical measurements are then calculated based on the segmentation rule. If the mean exceeds a threshold value determined by trial and error, the central element of the window is designated as the ROI.

Two windows stop moving once the entire image has been scanned.

Another SCW for Korean license plates has been proposed by Kaushik Deb et al [13]. The hue-intensity-saturation (HIS) color model is used for color verification after using the SCW methodology. Tilts were rectified by utilizing the minimal square appropriate for perpendicular offsets.

Zhen-Xue Chen et al. [14] suggested a method for removing a car number plate using differentiating attributes such as form, texture, and color, as well as a distinct tool.

The authors presented the Hough transform to identify vertical and horizontal lines for the license number plate, which was then converted to (RGB) (HIS).

Hui Wu and Bing Li [15] proposed a method for determining the horizontal and vertical distinctions for locating the rectangle with a car plate, especially for Chinese plates. The authors employed MATLAB's automated binarization to convert a vehicle image to a grayscale image.

Ch.Jaya Lakshmi et al. [16] proposed a one-of-a-kind approach for identifying Indian car plates using textural features and water. In addition, the editors employed morphological operations[17, 18] for good efficiency in a challenging environment. Vertical edges are detected using the Sobel mask.

M. S. Sarfraz et al. [19], a reaction to the author's recommendations about adjusting camera distance and lighting conditions. Vehicle plate detection could be a four-step procedure that includes contours and connected sections, size and ratio-based rectangular region selection, first-class learning for changeable camera distance/height, position-based bar map, gradient process, and closest mean classifier. The final detection result from these processes is then forwarded for tracking.

A fuzzy discipline-based technique is developed by Shyang-Lih Chang et al [20] for car plate recognition. The edge detection algorithm is only sensitive to black-white, red-white, and green-white edges throughout this proposed methodology.

3. Methodology

In the proposed algorithm for detecting and recognizing vehicle numbers in this part. We also go over each step's labor and outcome in depth. This approach is also applicable to a slanted image. Discuss some of the basic stages of image processing that were done during this procedure. Pre-processing entails resizing the image to a specific size by inserting the shape information into the suggested position algorithm, converting the number plate image to gray scale, extracting noise such as luminance and brightness from the resulting gray scale image, and converting the filtered image to a binary image to allow translation and computation with a computer. There are four fundamental phases to the suggested methodology for automatic number plate recognition. Figure 1 depicts these periods in greater detail.

A. Data Acquisition

Images of the vehicle make up the data set for this project. A total of 300 vehicle photos have been obtained. The photographs obtained are jpg images in color. To compensate for a total of 300 vehicle images used in the experiment, 50 of the 300 images obtained from the vehicle were captured by a Nixon D7000 digital camera, while the remaining 250 photos from other countries were obtained from online databases, namely web: http://www.medialab.ntua.gr/research/LPRdatabase.html and CV papers: http://www.cvpapers.com/datasets.htm l. The photographs were taken at a distance of 10 feet on average from the vehicle. Figure (8) shows a selection of the 300 photos of the vehicle that were utilized in the experiment. The proposed method was created using Open CV and the Matlab programming language, and its performance was evaluated using 300 car photos. The Nixon D7000 digital camera features a 650 x 550 pixel resolution.

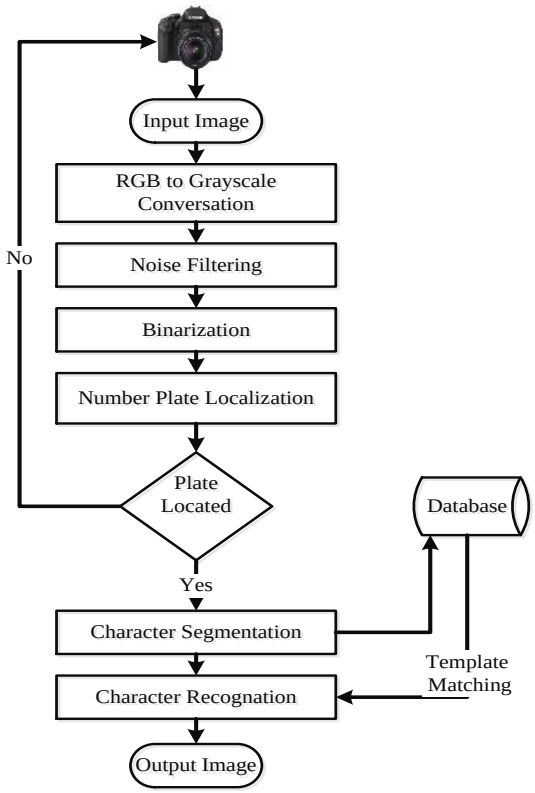

Figure 1. The General Proposed system.

B. Image Pre-Processing

As illustrated in figure 2, the process of pre-processing the image of the vehicle's number plate goes through the following stages.

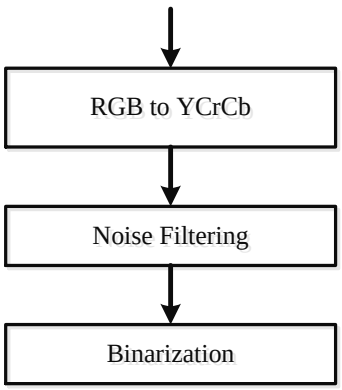

Figure 2. Image Pre-Processing Stage.

i. **RGB to grayscale**: after the image is taken from the camera, the image is converted from RGB to grayscale for the purpose of easy treatment.

• Noise filtering: 5x5Median filtering is used to filter the noise. The median filter is used to remove unwanted noisy regions from the image. During the filtering process, the 5x5 matrices are moved around the image. The size of such matrices is determined by the amount of noise present. • One pixel is chosen as the 5x5 matrix Center pixel in the operational form.

• The pixels around the perimeter have been designated as neighborhood pixels.

- The sorting mechanism is utilized from smaller to larger between these 9 pixels.
- The fifth element is designated as a median element.
- The methods outlined above are applied to all pixels in the figure 3 vehicle plate image.

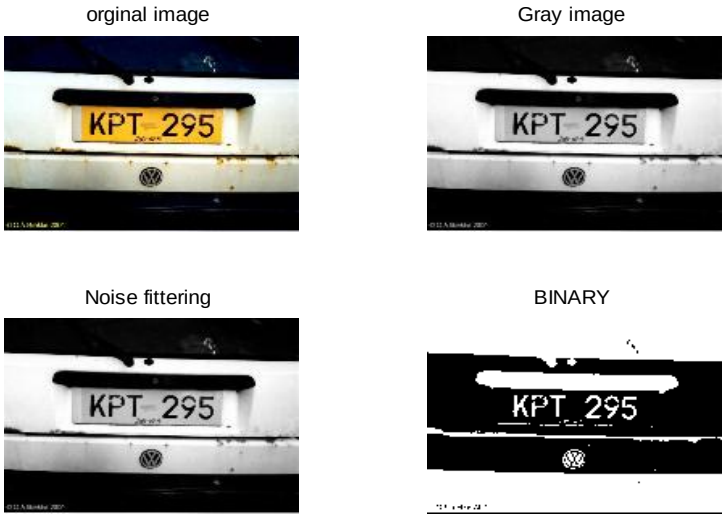

Figure 3. Image pre-processing.

ii. **Binaraization**: The threshold is an active way to convert grayscale images to a binary image (pixels that contain black and white pixels). For example, the binary image can be acquired either from a gray or colored image. Here in this paper, we studied the color image and then convert to grayscale before thresholding. Binary pixel values are obtained using the characteristic function as shown below. If $g(x, y)$ may be a thresholder version of $f(x, y)$ at some world threshold T.

$$g(x,y) = \begin{cases} 1 \; if \; f(x,y) \geq T \\ 0 \quad otherwise \end{cases} \tag{1}$$

The proposed algorithm rule for transforming gray image to binary image is discussed in figure 4 below.

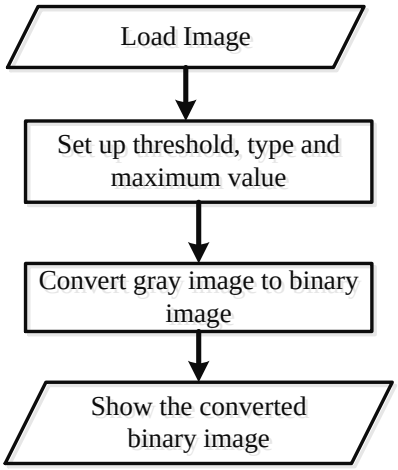

Figure 4. Convert Image to Binary.

iii. **Plate localization**: This algorithm is responsible for finding and isolating the plate on the picture. It is shown in figure 5.

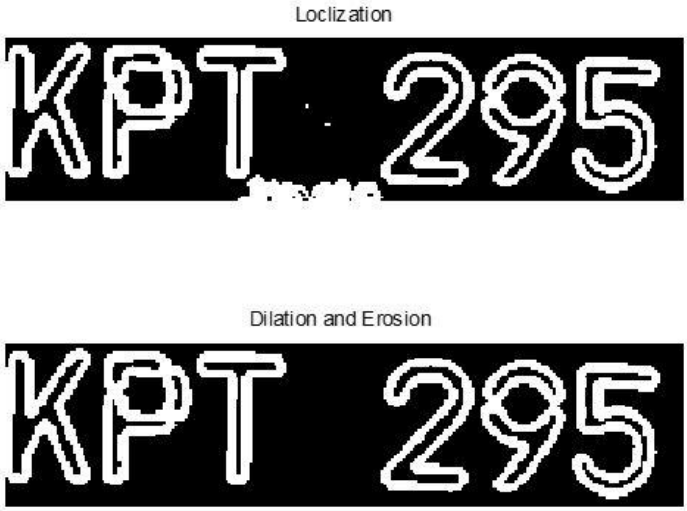

Figure 5. Plate localization.

- Erosion and dilation Dilation is a technique for improving the image's structure by filling gaps, adding pixels, and joining broken lines to sharpen the image's border while increasing brightness. During the pre-processing step, RGB to gray transmutation causes some characteristics of the original image to be lost. Even noise may wreak havoc on an image. As a result, dilation is required to reinforce the transformed image by reducing noise, sharpening edges, and establishing the proper edge form. By creating the edge sharper the gray value distinguishing within the neighboring pixels of an objective will increase. This enhances edge efficiency even further.

- When some key qualities of a picture, such as brightness and light edge, are preprocessed, a color distinction may be lost. Dilation is typically used to compensate for such losses, resulting in a sharpened pre-processed image and increased brightness. One of the two fundamental mathematical morphology and dilation operators is erosion. Erosion is commonly employed on binary pictures. Some versions, on the other hand, operate with grayscale photos. The degradation of front pixel boundaries is the operator's principal influence on the binary image (generally white pixels).

iv. Character Segmentation: Using a proposed algorithm for the purpose of segmented of the image resulting from the process of dilation and erosion into characters. This returns algorithm produces the smallest perimeter of boxes consisting of one character. This method is used to acquire box perimeter for all characters inside the plate number. As Figure 6 shows.

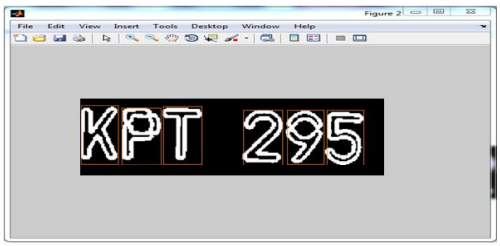

Figure 6. Character Segmentation.

v. OCR Using Template Matching: Matching is one of the essential technique used to identify characters. It is the method of finding the location of a sub-image within a object, known as an example. The criterion for matching includes determinative similarities between a given example and windows of the same size in a image, and the window with the best similarity activity. This works for any possible displacement of the example by comparing each pixel by pixel of the image, and also the example. This method requires the use of a character or template data. An example exists for all possible input characters. Templates area unit generated for each alphabetic character (from A-Z and 0- 9) font type 'Regular'. Results of vehicle pictures recognition show in figure 7.

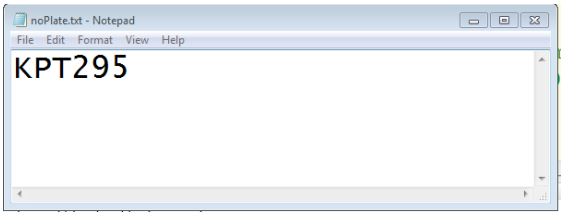

Figure 7. Result of vehicle images recognition

4. Simulation Performance Results

The performance of the system was measured using the system throughput, during this section, we tend to provide the analytical results of the proposed algorithm and evaluate the process of localization of the vehicle number plate and also offer a differentiation of our proposed algorithm with the current methods. Within the experiments, we have a tendency to judge our methodology on an Intel Core i7 PC with 2. 50 GHz CPU 6 GB RAM and Windows 8 software system. The image collection includes300 different pictures with a same size of 480 × 640 every the analytical results of the suggested algorithmic program gave correct localization of LPs as shown in fig.8. An associate accuracy of 99. 7% was achieved for vehicle number plate localization as given in Table 1. This accuracy is obtained from eq.(2).

$$AVPL = \frac{\text{Successful Samples}}{\text{Total number of Samples}} \times 100 \quad (2)$$

Where AVPL is Accuracy of Vehicle Plate Localization.

Table 1. Accuracy of Vehicle Number plate Localization.

Parameters	value	Percentages
Number of images vehicles used	300	100%
Number of correctly localized plates	299	99.7%
Number of incorrectly localized plates	1	0.3%
Number of plates not found	0	0%

The comparison between our proposed technology and other existing technologies shows in Table2.

Table.2 Comparison of results of the different Vehicle plate algorithms and their localization accuracies.

Main works	Techniques used	Accuracy (%)	Processing time	System properties
Roy and Ghoshal [21]	Labelling of components and region that grows on LP	91.5%	Not specified	Not specified
Zhou et al. [22]	Central visual word and local corresponding features	93.2%	0.22	PC with 4-G memory and 2.53-GHz CPU
Owamoyo et al. [23]	Sobel filter, Morphology and CCA operations	85.0%	Not specified	Not specified
Hemayat et al. [24]	Threshold dynamics	95.3%	Not specified	Intel Core CPU 2.0 GHz RAM
Gou et al. [25]	Extreme regions (ERs), and machines from Boltzmann	95.9%	0.40	PC with 3.1-GHz Intel Core 2 Quad CPU and 4-GB RAM
Wang et al. [26]	SIFT-Function	96.0%	0.26	Pentium 4 with 2.4 GHz CPU and 1 GB memory
Azam and Islam [27]	Binarisation and radon transfer figures	86.2%	0.73	Intel Core 2 Duo CPU T6600 with 2.2 GHz processor and 2 GB RAM
Danbatta et al. [28]	Detecting bubble	91.4%	15.00	Not specified
Wang et al. [29]	Color space HSV	75.8%	Not specified	Intel Core i7-3537 U with 2.50 GHz CPU
Saini and Saini [30]	Transforming Multiwavelets	98.3%	Not specified	Intel Core i7 with 3.60 GHz CPU
Proposed Method	The proposed technique	99.7%	0.21	Intel Core i5 PC with 2.6 GHz CPU and 8 GB RAM

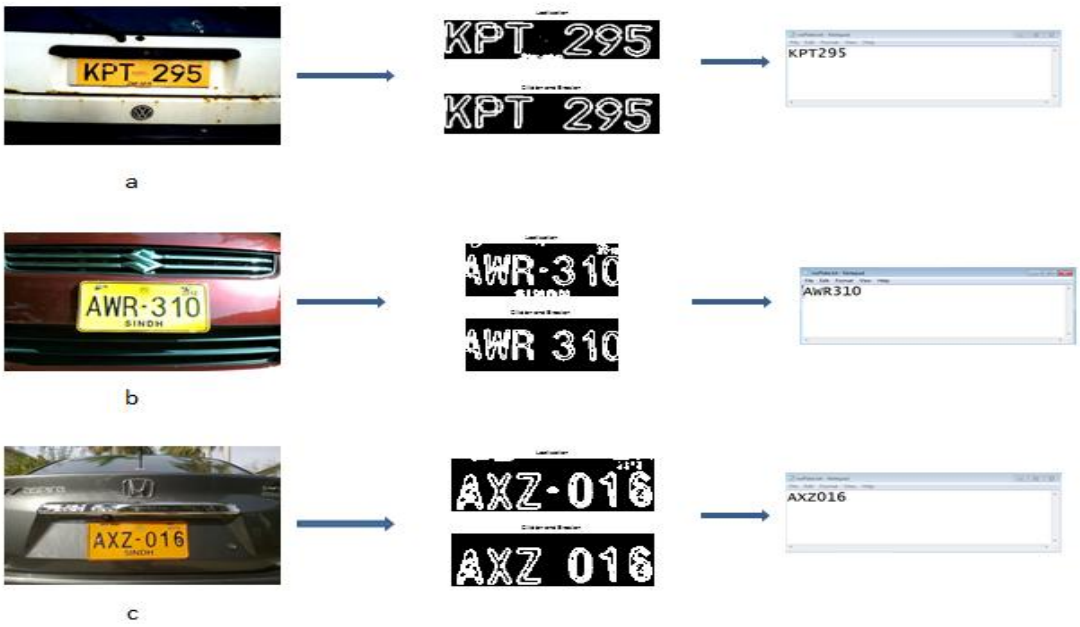

Fig. 8. Some images of vehicles used for testing
1. Vehicle images (a), (b) and (c) Source: Computer Vision datasets:
http://www.medialab.ntua.gr/research/LPRdatabase.html
2. Shown of the localized vehicle images (a), (b), and (c).3. Result of recognition of images.

5. Conclusion

In this article, a powerful and effective method for locating automobile license plates is presented. The suggested method is not country-specific and may be used to recognize car number plates with a variety of sizes, complex backgrounds, changing lighting, and weather conditions. 300 composite picture examples from various nations were used to evaluate the suggested technique. The results of the experiments revealed that the proposed algorithm has a high accuracy of 99.7% and a processing time of only 0.21 seconds. This algorithm's capabilities will be improved in the future to incorporate motorcycle localization.

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