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License Plate Detection and Character Recognition Using Contour Analysis

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ABSTRACT

License Plate Detection and Recognition System is an image processing technique used to identify a vehicle by its license plate. Here we propose an accurate and robust method of license plate detection and recognition from an image using contour analysis. The system is composed of two phases: the detection of the license plate, and the character recognition. The license plate detection is performed for obtaining the candidate region of the vehicle license plate and determined using the edge based text detection technique. In the recognition phase, the contour analysis is used to recognize the characters after segmenting each character. The performance of the proposed system has been tested on various images and provides better results.

Key words: License plate detection, character segmentation, thinning, character recognition, license plate recognition (LPR) and contour analysis.

1. INTRODUCTION

License plate recognition system has an important application in surveillance technologies which are constantly being developed and for collecting information about the vehicle. A license plate consists of numeric or alphanumeric code that uniquely identifies the vehicle within the issuing region's database. Recognition of license plate is an image processing system which is essential to avoid a huge number of traffic violations and it is an integral part of transportation system. License plate recognition system is popular because of its successful applications in toll payment monitoring, traffic congestion and monitoring, parking management systems etc.

License plate recognition system consists of two main phases: License plate detection and character recognition. Detection is to identify the region from an image which contains the license plate. The process of recognition converts the characters into editable format. In the proposed system, the color image which is converted into binary image is used as the input to the recognition system.

The license plate recognition system that recognizes a license plate character from a given image can be composed of mainly two stages. The first stage is to extract the license plate region from the image based on the features like character alignment of license plate [2]. The edge based extraction technique effectively localizes and extracts the character from image by finding the vertical edges [3]. Since the rectangular shape of the license plate has a known aspect ratio property [4], it is easy to extract the license plate by finding all possible rectangles in the given input image [5]. The second stage is to recognize the extracted characters by using contour analysis after finding the contour of segmented character [6]-[8]. Contour analysis includes the vector representation of each contour characters and matching is done using the scalar product of each complex vector representation with previously stored pattern in the training phase.

The paper is organized as follows. In section 2, we present a literature review that describes a brief summary of some of the techniques that have been used for license plate recognition. Proposed methods detection and recognition are discussed in Section 3. Result analysis is drawn in Section 4 and finally Conclusion in Section 5.

2. LITERATURE REVIEW

Previously different models where designed for detecting and recognizing the license plate, some of the related work is as follows. Since the license plate normally has a rectangular shape with a known aspect ratio, it can be extracted by finding all possible rectangles in the image. Edge detection methods are commonly used to find these rectangles. Yingzi Du Chein-I Change and Paul D.Thouin, proposed a method for automated system for text detection in individual video images [2]. Xiaoqing Liu and Jagath Samarabandu, proposed a method for multiscale edge-based text extraction from complex images [3]. Thanongsak Sirithinaphong and Kosin Chamnongthai [4] proposed extraction of car license plate using motor vehicle regulation and character pattern recognition. Leandro Araújo, Sirlene Pio, David Menotti proposed a method for segmenting each character from the license plate [5]. The characters are segmented using the height and width the result produces individually segmented

characters. Krešimir Romić, Irena Galić, Alfonzo Baumgartner [7] proposed the thinning algorithm which is applied for finding the boundary of each character. The boundary will be of single pixel thickness. Our proposed system uses contour analysis [8] for the recognition of characters by applying vector multiplication and several other operations.

3. PROPOSED METHOD

A license plate recognition system based on contour analysis is analyzed in this paper. The system consists of two stages: license plate detection and character recognition. The license plate region is detected from the input image. Contour analysis which consists of contour extraction and vector representation is applied to the segmented characters. The recognized characters are obtained after character matching.

In this section we discuss about our proposed system. Figure 1 shows the model of license plate detection and recognition system used in this paper.

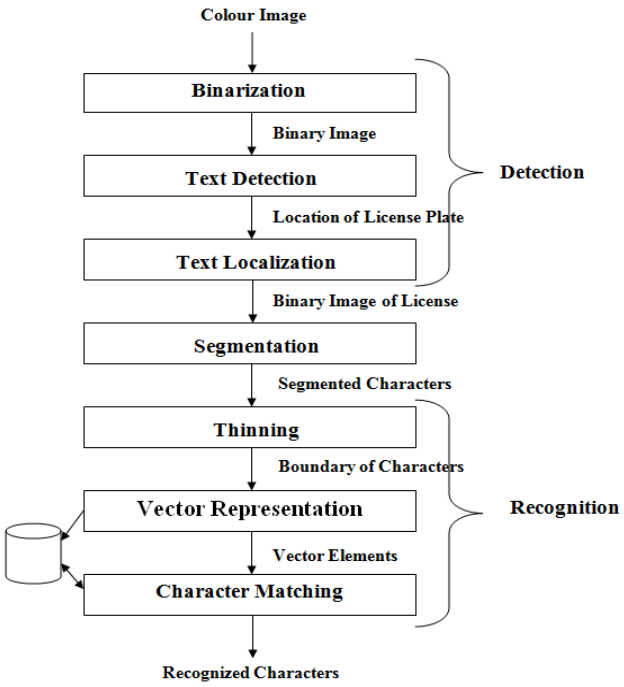

Figure 1: License Plate Detection and Recognition.

Color images of vehicles are used as input to the system. RGB to binary image conversion is adopted using global thresholding algorithm, in order to process the license plate detection, and increase the processing speed. Color image (RGB) acquired by a digital camera is converted to gray-scale image and then to binary images based on the RGB to binary conversion technique [1]. Images are also known as black-and-white varying from black at the weakest intensity to white at the strongest. This conversion is the most important stage in all phases of the LPR system, and more specifically for license plate detection phase.

3.1 License Plate Detection

Detection of plate is a difficult task. Essentially, the difficulty can be due to the following reasons: License plates normally occupy in a small portion of the whole image, the difference of license plates in formats, styles and colors differ from country to country. In most cases, the detection is performed without prior knowledge of the license plate's location in the image and probability of facing some common drawbacks which could influence the efficiency of the detection such as, blurry image, uneven or low illumination, vehicle motion, low resolution of the image, distorted characters, dirty plate, shadows or reflection etc. There are many techniques such as region based technique, edge based technique, texture based technique etc. for text extraction [2]. Edge based technique is used in our proposed system in order to detect the text from the license plate image.

(a)Edge Based Technique

The proposed system uses edge based detection technique for locating the license plate region [3]. Edges are important feature of text regardless of color/intensity, layout, orientations, etc. Three distinguishing characteristics of text embedded in images are used as the main features for detecting text. Edge based method consists of two stages: text detection and text localization.

(i)Text Extraction

It refers to the determination of the presence of text in a given frame. The three important properties of edges such as edge strength, density and variance of orientation are used in this phase in order to build a feature map. Here several spatial filters are designed to remove noisy regions and regions that do not contain text.

(ii)Text Localization

It is the process of determining the location of text in the image and generating bounding boxes around the text. Normally text in the image appears in clusters. Thus characteristics of clusters can be used to localize text region. Since a text region that contains characters almost always appears as a box, the purpose of the text localization is to rectangularize the text regions detected by the text detection and produce text boxes as shown in figure 2.

Figure 2: License Plate Detection from Input Image

(b)Character Segmentation

Character segmentation is the procedure of segmenting the license plate area into smaller parts which represent each character of the license plate. These images have the same height as the license plate image, but the width varies depending on the width of each character [4]. The black pixels on the license plate region represent the characters. The number of black pixels is counted in both vertical and horizontal direction of the license plate region [5]. According to this count, each character is separated and the process is repeated until every character is segmented as in figure 3.

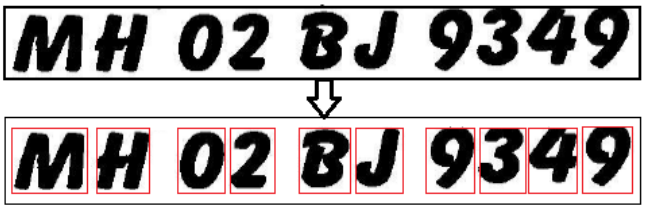

Figure 3: Character Segmentation

3.2 Character Recognition

In this section, an algorithm for character recognition is developed based on contour analysis, which considers only the contour of characters. Character matching is performed using the character contours obtained from contour analysis. The process of character recognition is repeated for each character obtained in character segmentation. This process could be carried out in several steps. The output should be the recognized characters of the license plate.

(a)Contour Analysis

The contour analysis allows to describe, store, compare and find the characters presented in the form of the exterior outlines. It is supposed that the contour contains the sufficient information on the character shape. Interior points of the characters are not accepted in our system. The contour is the boundary of characters, a population of points (pixels), separating character from a background, which is obtained from thinning.

(i)Thinning/Contour Extraction

The fundamental action is to make the boundary of characters 1 pixel thin. It observes the image pixel by pixel and erases the inner layers of black pixels on every character [6]. The image is observed repeatedly until every character boundary is reduced to single pixel thickness [7]. The character contours are shown in figure 4.

Figure 4: Character Contours

(ii)Vector Representation

In a contour analysis, the contour is defined by the sequence consisting of complex numbers which are represented by the vectors. On a contour, the point which is called as starting point is fixed and then, the contour is scanned (clockwise), and each vector of offset is noted by a complex number a+ib, where a is the point on x axis, and b is the point on y axis [8]. Offset is noted concerning the previous point. Vector representation of characters is shown in figure 5.

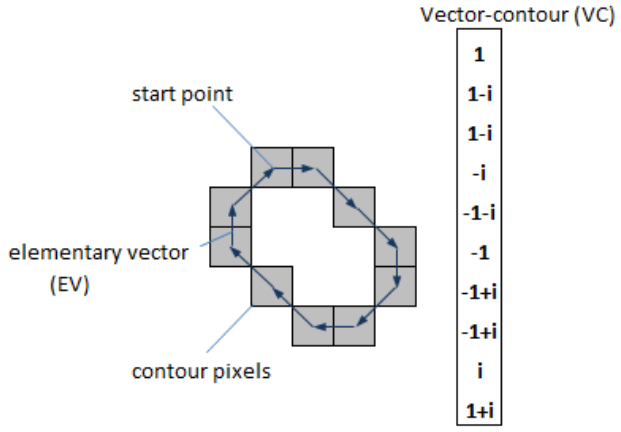

Figure 4: Vector Representation of Character

As per the physical nature of characters, their contours are always closed and cannot have self-intersection. It allows to define a way of bypassing of a contour (to within a direction - on or counter-clockwise). The last vector of a contour always leads to the starting point. Each vector of a contour we will name elementary vector (EV). And sequence of complex-valued numbers - vector-contour (VC).

(b) Character Matching

The vector representations of the standard characters are saved in the memory or in a file. These vector representations are used for the scalar multiplication of contours. The license plate characters are recognized if the scalar product of the vector representation of standard characters and the obtained characters are equal to 1.

Scalar Product of Contours

The scalar product of complex numbers is calculated as:

$$(a+ib,c+id)=(a+ib)(c-id)=ac+bd+i(bc-ad) \qquad (1)$$

Here the first and second complex numbers represents each pixel of the character to be recognized and the predefined standard character respectively. If for every pixel, the result of the scalar product equals 1, then the vector contour of the recognized character and the predefined standard character (which includes the vector contours) matches. The output of this process should be a recognized character.

4. PERFORMANCE EVALUATION

The processing of 50 images using our proposed method presented here resulted in 98% accuracy in the detection and recognition of license plate. The proposed system shows poor performance, when the obtained image is low contrast or blurred.

5. CONCLUSION

This paper proposes a method for character detection and recognition of license plate image based on contour analysis. To identify a vehicle, license plate is essential, because it provides unique information about the vehicle. The proposed system is composed of two phases: license plate detection and character recognition. License plate localization is performed to obtain the accurate location of the license plate region. Since the edge based detection technique gives a better performance it is used in our system for the detection of license plate region. Then segmentation of the license plate area into smaller parts is performed, which represent each character of the license plate. Finally the characters are recognized using contour analysis by determining the vector elements. Since the contour analysis does not need any training, the system works at a faster rate. The performance of the test results demonstrate that the proposed method is efficient to be used for the license plate recognition system.

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