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Automatic Skew Detection and Localisation of Vehicle License Plate Using Hough Transform

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Abstract— Automatic Skew Detection and Localization of Vehicle License Plate Using Hough Transform are used to identify a vehicle by its number plate. The proposed algorithm consists of three major parts: Extraction of plate region, segmentation of characters and recognition of plate characters. The proposed license plate localization algorithm is based on a combination of several algorithms that include Thresholding, Edge Detection and Hough rectangular transforms. The process flow is, initially the Thresholds are performed on a plain image. Then edge detection is applied to the obtained image and then location is found using top hat transform and then the skew is detected by using the Hough Rectangular Transform and correct it and finally get the localized number plate from the digital image as a deskewd image. After that Connected component analysis is used to segment the characters individually and finally statistical based template matching is used for recognition of plate characters.

Index Terms— Top Hat Transform, Skew detection, connected component analysis, Template matching.

1 INTRODUCTION

Automatic License Plate Recognition (ALPR) is a challenging area of research due to its importance to variety of commercial applications. ALPR systems are widely implemented for automatic ticketing of vehicles at car parking area, tracking vehicles during traffic signal violations and related applications with huge saving of human energy and cost. The overall problem may be subdivided into three distinct key modules and they are shown in fig 1:

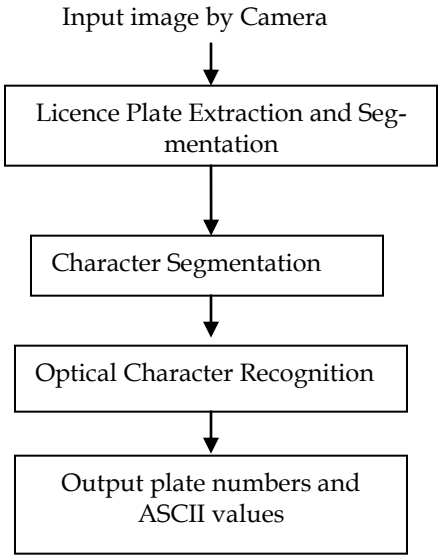

Fig 1: Flowchart of a Typical ALPR System

From these three modules, the localization of potential license plate regions(s) from vehicle images is the most challenging task due to the huge variations in size, shape, color, texture and spatial orientations of license plate regions in such images. In general, objective of any ALPR system is to localize potential license plate region(s) from the vehicle images captured through a road-side camera and interpret the segmented characters present therein using an Optical Character Recognition (OCR) system, to get the license number of the vehicle. An ALPR system can have two varieties: on-line ALPR system and off-line ALPR system. In an online ALPR system, the localization and interpretation of license plates take place instantaneously from the incoming video frames, enabling real-time tracking of moving vehicles through the surveillance camera. On the other hand, an offline ALPR system captures the vehicle images and stores them in a centralized data server for further processing, i.e. for interpretation of vehicle license plates.

The objective of the current work falls under the second category of ALPR system. In this work, real time vehicle images are captured from a road-side surveillance camera automatically throughout day and night. The images are stored in a centralized data server. Various methods and techniques have already been developed during last couple of decades for the purpose for efficient localization of license plate regions from offline vehicular images.

2. RELATED WORK

There are several common algorithms to locate the license plate. Searching algorithms mainly rely on color information and special signs. Widely used procedures that are solely based on image processing are as Hough transform, Top-Hat and Bottom-Hat filtering (highlights the black-white transitions) Binary morphology algorithm (for example: classical Otsu method) [5] Edge finding methods (Sobel, Laplacian, Roberts, Prewitt, Canny operators) [2] Procedures based on the color of the background and characters. Region-growing algorithm (RGA): By using a recursive region-growing algorithm, the dark regions (license plate symbols) surrounded by light areas (background of the license plate) can then be classified. Each region has a unique position and dimensions.

Presently, there are several common algorithms for the segmentation of license plate characters [1], such as direct segmentation, template matching, projection and cluster anal-

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ysis. In the direct segmentation algorithm [1], the license plate characters are segmented directly according to the prior knowledge of the width of characters and spaces between characters. This algorithm is simple and rapid. But the left and right side of characters region must be located accurately before using it. So it is reliable to the effect of license plate location.

In the template matching algorithm [3], a template is used to scan the image of license plate to find the maximum difference value of the number of white points between the region of character and the region of space between characters. This algorithm can avoid falsely segmenting characters.

In the projection algorithm with template matching [8] [9], the number of white points in vertical direction is counted and recorded. The character region has more white points than the region of space between characters. By detecting the rough of white points between characters, the spaces can be located and then the boundary of characters can be located.

Character Recognition uses the basic methods as pattern recognition and Neural Network based recognition systems. (1) In Pattern Recognition method [10], the character can be written differently so the pattern may vary. This may give false result. (2) Neural Network based method; this system needs training to recognize the characters. In this computational time depends on the training set and also it is very expensive.

3. THE PROPOSED SYSTEM

3.1 Steps Involved in Skew detection and localization of number plate:

3.1.1 Plain image

This image is captured by using the cc camera which has the skew; if the image has no skew then steps are done as the previous work.

3.1.2 Thresholding

In order to implement the threshold [5] first we obtain the grayscale image from a binary image. Threshold is the simplest method of image segmentation [9]. From a grayscale image, thresholding can be used to create binary images. Here the Otsue Thresholding is used to get the binary image.

3.1.3 Edge Detection

Edge detection is a fundamental tool in image Processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities.

The edge detection technique used here is "Canny Edge Detection". Canny edge detection considered the mathematical problem of deriving an optimal smoothing filter given the criteria of detection, localization and minimizing multiple responses to a single edge. It is showed that the optimal filter given these assumptions is a sum of four exponential terms. This filter can be well approximated by first-order derivatives of Gaussians. Canny edge detection also introduced the notion of non-maximum suppression, which means that given the pre-smoothing filters, edge points are defined as points where the gradient magnitude assumes a local maximum in the gradient direction? In this step the binary image is taken as input and edge detection technique is performed and the canny image is obtained.

3.1.4 Top Hat Transform

Gray scale top-hat transform is a mature algorithm using in digital image processing. Its advantage is to enhance the hot region where front and background have obvious differences while weakening the other regions at the same time. It is popular to use top-hat transform to compensate background luminance or emphasize texture information in grayscale mathematical morphology [11]. Its first step is opening operation. If the structuring element is larger than the object that you want to pick up, then these objects will be deleted only leaving the background.

The next step is to subtract the image processed by opening operation, using the original image. As the result, only the objects will be left. The algorithm in this paper presents the top-hat transform of binary image according to the theory above. Its first step is dilation, a different step from top-hat transform of grayscale image. The second step is to subtract the image processed by dilation using the original image. Furthermore, in order to emphasize vertical textures, another opening operation, with the structuring element larger than the height of words and shorter than the width of words, is needed. The opening operation can be divided into two steps, erosion and dilation.

3.1.5 Skew detection and correction

The main objective of the auto-skew correction process is to improve the candidate evaluation process and the rate of successful recognition for the character recognition module. The developed auto-skew correction process is also based on the Hough Transform [4]. The resultant candidates of the modified Hough Transform approach are the inputs to this process. The Following shows the image with the skew.

Fig 2: Skewed Image

Using the Hough transform find the skew angle by locating the angled plain in a domain of length. This angle will be passed in to the skew correction by using the rotation process [5]. Then get the image as the deskewd image.

Fig 3: Deskewed Image

3.1.6 Isolating the number plate

From the output of the Top Hat transform only the number plate is isolated using the function ROI that is region of interest in the Opencv. The isolated license plate, Image after performing ROI

3.2 Character Segmentation

Connected components scans an image and groups its pixels into components based on pixel connectivity [7], i.e. all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. This method requires the input image to be converted into binary for processing. The boundary of each object is checked to see if it occupies expected area. This method makes use of the property that all license plates are rectangular and the characters on them share the same background.

Fig 4: Segmented Characters

3.3 Character Recognition

Before recognition algorithm, the characters are normalized. Normalization is to refine the characters into a block containing no extra white spaces (pixels) in all the four sides of the characters. Then each character is fit to equal size in the database.

Fitting approach is necessary for template matching. For matching the characters with the database, input images must be equal-sized with the database characters. Here the characters are fit to 36 □ 18. The extracted characters cut from plate and the characters on database are now equal-sized. The next step is template matching. Template matching is an effective algorithm for recognition of characters. The character image is compared with the ones in the database and the best similarity is measured.

To measure the similarity and find the best match, a statistical method correlation is used. Correlation is an effective technique for image recognition which was developed by Horowitz. [1] This method measures the correlation coefficient between a number of known images with the same size unknown images or parts of an image with the highest correlation coefficient between the images producing the best match. There are two forms of correlations [10]: auto-correlation and cross-correlation. Auto-correlation function (ACF) involves only one signal and provides information about the structure of the signal or its behavior in the time domain. Cross-correlation function (CCF) is a measure of the similarities or shared properties between two signals. Since there are two signals as unknown input image and known database image in this system, cross-correlation is used.

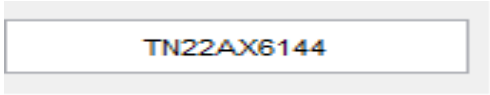

Fig 5: Number Plate Characters

4. EXPERIMENTALRESULTS

Experiments have been performed to test the proposed system and to measure the accuracy of the system. The system is designed in Matlab 2009 for recognition of Turkish license plates. The images for the input to the system are colored images with the size of 1200□1600. The test images were taken under various illumination conditions. The results of the tests are given in Table 1.

TABLE 1
Performance Metrics

Units of License Plate Recognition System	Percentage of accuracy
Extraction of plate region	97.5
Segmentation	97
Recognition of characters	97.6

It is shown that accuracy for the extraction of plate region is 97.5%, 97% for the segmentation of the characters and 97.6% is the percentage of accuracy of the recognition unit. The overall system performance can be defined as the product of all units accuracy rates (Extraction of plate region, segmentation of characters and recognition of characters).

5. CONCLUSION

Application software designed for the recognition of car license plate which has. Firstly we extracted the plate location with the input image and also with the skew angle, and then we separated the plate characters individually by segmentation and finally applied template matching with the use of correlation for recognition of plate characters. This system is designed for the identification license plates and the system is tested over a large

number of images. Finally it is proved to be 97.5% for the extraction of plate region, 97% for the segmentation of the characters and 97.6%for the recognition unit accurate. This system can be redesigned for multinational car license plates in future by using an algorithm Hough transform to detect the skew angle in an image.

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