



Hough Transform and Its Application in Vehicle License Plate Tilt Correction

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Abstract

In a vehicle license plate recognition system, tilt vehicle license plate has a bad effect on its character segmentation and recognition. In this paper, tilt models of a plate are analyzed and a approach for number plate tilt correction is presented. Hough Transformation is an effective method to obtain vertical or horizontal angle. Though rotating a correct angle, Tilt vehicle license will be rectified using interpolation a rotation method. Experimental result shows that the method can be implemented easily when dealing with dirty number plates and license plate in variant lighting conditions.

Keywords: Vehicle license plate, Hough transformation, License plate recognition

1. Introduction

The Hough Transform is a global method for finding straight lines hidden in larger amounts of other data. It is an important technique in image processing. For detecting lines in images of vehicle plate, the image is first binarised using some form of threshold and then the positive instances catalogued in an examples dataset. The images of vehicle plate have obvious line which is edge of plate. By using binarised, the edge will be a rectangle. Because each point (d, t) in Hough space corresponds to a line at angle T and distance D from the origin in the original data space. The value of a function in Hough space gives the point density along a line in the data space. For each point in the original space consider all the line which go through that point at a particular discrete set of angle, chose a priori. For each angle T , calculate the distance to the line through the point at that angle and discretise that distance using a priori chosen discretisation, giving value d . Make a corresponding discretisation of the Hough space –this will result in a set of boxes in Hough space. These boxes are called the Hough accumulators. For each line we consider above, we increment a count (initialized at zero) in the Hough accumulator at point (d, t) . After considering all the lines through all the points, a Hough accumulator with a high value will probably correspond to a line of point. So the angle of line will be obtained. At last, rotating a certain angle will rectify the vehicle license plate.

2. Pre-processing of image

In order to improve the accuracy and efficiency in the process of Hough transformation, the image of the vehicle plate must be processed by the Global Threshold Binarization Method. The simplest way is choose a threshold value, and classify all pixel with value above this threshold as white, and all other pixels as black. For the vehicle plate the pixel value is easy to find the right the threshold by calculating average value of all pixel value in the image. Experiment shows that this method can get the best binarization threshold distinguish the edge and background perfectly. Meantime, it can also avoid disconnection. Figure.1, Figure.2 show the result of binarizing processing.

3. Hough transformation and straight line detection

The Hough transformation is a standard tool in image analysis that allows recognition of global patterns in an image space by recognition of local pattern in a transformed parameter space. It is particularly useful when the patterns one is looking for are sparsely digitized have “holes” and the picture are noisy. Especially in detected straight line in the licenses plate.

The basic idea of this technique is to find curves that can be parameterized like straight lines in a suitable parameter space.

As show in figure 3, we assume them parameterized in the form: $\rho = x \cos(\theta) + \sin(\theta)$, where ρ is the perpendicular

distance from the origin and θ the angle with the normal. Collinear point (x, y) with $i=1, \dots, N$, are transformed into N sinusoidal curves $\rho = x_i \cos(\theta) + y_i \sin(\theta)$ in the (θ, ρ) plane, which intersect in the point (θ, ρ) .

Care has to taken when one quantizes the parameter space (θ, ρ) , when the bins of the (θ, ρ) space (it is easy to visualize the transform as a two-dimensional histogram) are chosen too fine, each intersection of two sinusoidal curves can be in a different bin. When the quantization is not fine enough, on the other hand, nearly parallel lines which are close together will lie in the same bin.

For a certain range of quantized values of parameters ρ and θ , each (x, y) is mapping into the (θ, ρ) space and the points that map into the locations are accumulated in the two-dimensional histogram THIST (ρ_m, ρ_m) , i.e. $\text{THIST}(\rho_m, \rho_m) = \text{IHIST}(\rho_m, \rho_m) + 1$. if a grey level image $g(x, y)$ is given, and g is the grey value at the point (x_i, y_i) the grey values are accumulated: $\text{IHIST}(\rho_m, \rho_m) = \text{IHIST}(\rho_m, \rho_m) + g_i$.

In this form, the Hough transform is not basically different from the discrete Radon Transform typically used for reconstruction of three-dimensional images from two-dimensional projections.

Local maxima of the pixel intensity $\text{IHIST}(\rho_m, \rho_m)$ identify straight line segments in the original image space. Ideally, the Hough domain has to be searched for a maximum only once. In situation where a picture contains many patterns of different size, it may, however, be necessary to take out first those patterns in the original image space that correspond to clearly identifiable peaks in the Hough domain and to repeat the process.

We can see the process that The Hough Transformation used in the license plate from Figure3 and Figure4. The Figure3 is original image space, the pixel value is accumulated in The Hough Transformation space. In the Figure5, there are two peak points which point into the long parallel lines which are the edge of The License Plate. The value θ is the angle of The Vehicle Plate Tilt. At last, the angle will be obtained.

4. The types of vlp tilt

The image of the vehicle plate is got by camera from different direction. So the pictures are different. On the whole, they can be divided into three different types such as the horizontal tilt, the vertical tilt, the horizontal and vertical tilt. The models of their tilts are shown in Figure.6, Figure.7, Figure.8.

5. Image rotation

The angle of the vehicle plate obtained, the last step is how to rotation certain angle. Image rotation is performed by computing the inverse transformation for every destination pixel. Output pixels are computed using bilinear interpolation. RGB image are computed by evaluating one color plane at a time. The follow formulation will show the principle of the rotation.

Before rotating

$$\begin{cases} x_0 = r \cos(\alpha) \\ y_0 = r \sin(\alpha) \end{cases}$$

After rotating

$$\begin{cases} x_1 = r \cos(\alpha - \theta) = x_0 \cos(\theta) + y_0 \sin(\theta) \\ y_1 = r \sin(\alpha - \theta) = -x_0 \sin(\theta) + y_0 \cos(\theta) \end{cases}$$

Matrix form

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 \\ -\sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_0 \\ y_0 \\ 1 \end{bmatrix}$$

Inverse operation

$$\begin{bmatrix} x_0 \\ y_0 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 \\ \sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix}$$

6. Result and conclusion

The Hough transformation is a standard tool in image analysis that allows recognition of global patterns in an image space by recognition of local pattern in a transformed parameter space.

A new method of Hough transformation is presented in this paper, experiments show that this method can accurately detected the line and obtain the angle. It is proved to be effective.

In the course of experiment, the methods of Hough transformation can accurately detected the line and obtain the angle.

This paper used by the algorithm can effectively in the car license plate image positioning, and can calculate the tilt angle plates, using interpolation method of rotating the position of cutting a correction. The results from simulation, the algorithm can tilt plates in a control error correction. About the results of this system to meet the requirements for the future lay the foundation for the segmentation of the characters.

Experiment results show that the method can be implemented easily and offers robustness when dealing with dirty number plates and license plates in variant lighting conditions.

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Figure 1. primitive image



Figure 2. Adjusted image

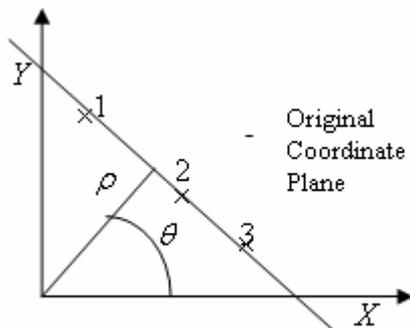


Figure 3. Define of line parameter

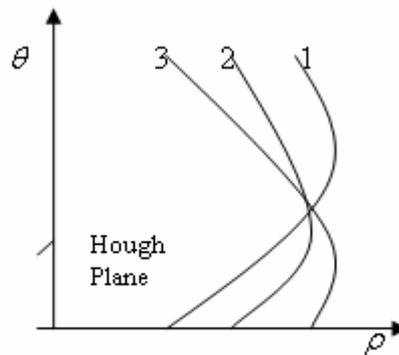


Figure 4. Hough transformation space

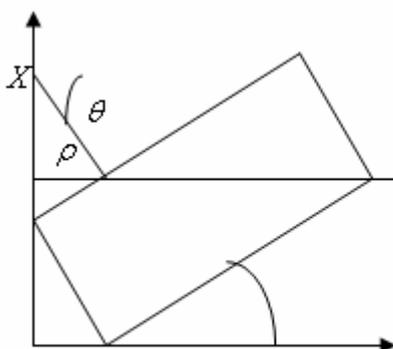


Figure 5. Original image space

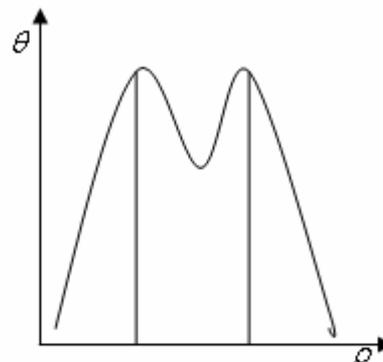


Figure 6. Hough transformation space

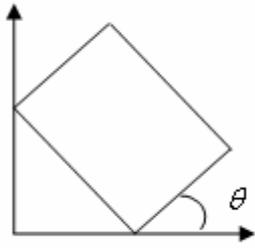


Figure 7. Horizontal tilt

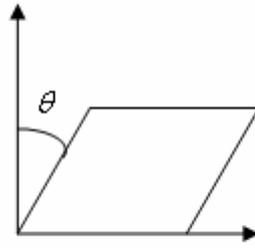


Figure 8. Vertical tilt

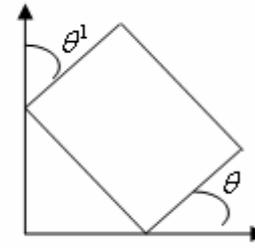


Figure 9. Horizontal and vertical tilt

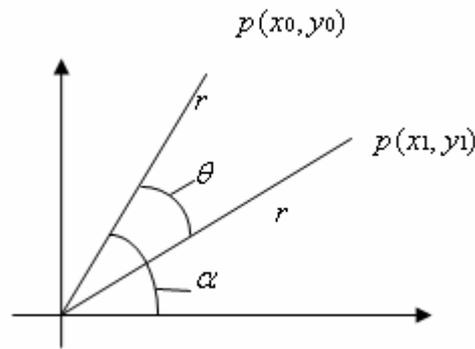


Figure 10. Rotating coordinates changes of point