Advanced Technique for License Plate Extraction

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Article Info
Page Number: 545-556
Publication Issue:
Vol. 70 No. 1 (2022)

Abstract

Automatic Number Plate Recognition (ANPR) is a mass reconnaissance tool that takes pictures of distant vehicles and reads their licence plates. In finding stolen vehicles, ANPR may be helpful. The ANPR systems installed on highways can be used to identify stolen vehicles in an efficient manner. The image of the vehicle plate is obtained by the digital cameras, and the image is then processed to extract the number plate data. Numerous algorithms are used to take and process a vehicle's rear image.

General Terms

Histogram, Image Processing, Skew Correction, Segmentation

Article History
Article Received*: 02 January 2022*
Revised: *10 February 2022*
Accepted*: 25 March 2022*
Publication*: 15 April 2022*

Keywords

License Plate Detection, Image Pre-processing, Digital Filter, Image Segmentation

Introduction

Each vehicle's license plate bears a unique identity number. With the use of the Vehicle Registration Plate Identification System, this could be recognized.

The way the Vehicle Registration Plate Identification System is used determines its consistency. Because of various factors, such as mist, showers, glooms, uneven lighting conditions, varying distances, the speed of the vehicle, the plate, tilt on the frame, plate screw, number of vehicles in the frame, etc., license plate identification has limitations. Owing to these factors, plate recognition is far more difficult and complicated than with standard systems [1] [2]. Therefore, we have spoken of how to use MATLAB to develop an algorithm for the Registration Plate Finding system.

For the execution of algorithms that require a significant amount of computing, particularly in image processing, MATLAB is a good alternative. Utilizing C and C++-related methods is easy and quick with MATLAB. A significant feature of MATLAB is the abundance of information analysis and image processing functions it offers. Any method may be quickly and accurately implemented and verified in MATLAB before being applied on actual hardware. While errors and recognition were corrected, implementing any algorithm on a hardware system is exceedingly challenging.

A simple methodology for debugging, fixing, and modifying any algorithm is offered by MATLAB. MATLAB is a better choice than other programming languages like C and C++ due to its extensive features for information analysis and image processing.

1. Flowchart Of Algorithm

In considering the above advantages, We implemented an algorithm for Registration Plate Recognition using MATLAB [3]. This technique makes use of both built-in and custom image processing-related functions.

The method was put to the test using many vehicles image samples. The built-in MATLAB functions are swapped out for customized functions once the technique has been thoroughly validated [4]. Figure 1's flow chart illustrates the processes in-volved in carrying out the procedure.

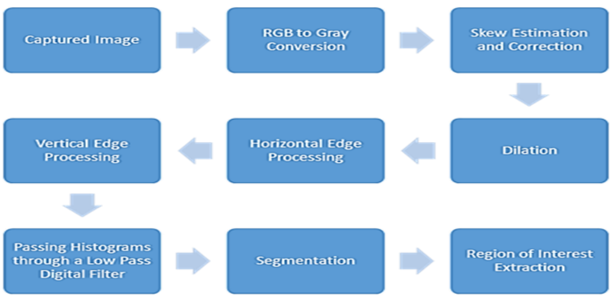

Fig 1: Flowchart of Algorithm

1.1 Convert RGB Image into Gray Image

The process described here focuses mostly on an image's Gray Level in order to man-age and extract the necessary data [5]. It is independent of the type of colours pre-sent in the image. Red, Green, and Blue are the three frequencies of an RGB image. RGB frequency is used by computer displays and image scanners to approximately track the color receptors in the human eye.

Assume that the RGB image is 24-bit, with 8-bits per channel. This means that the image is made up of three images, one for each channel, each of which can save unique pixels using standard illumination strengths between 0 and 255.

Consider a 48-bit (high resolution) RGB image [8] where each channel is made up of 16-bit images. Red, Green, and Blue values are not used consistently throughout this method.

Typically, the input image is RGB. Grayscale photos are created by transforming color images into grayscale since the brightness information is required for forward processing.

Fig 2: RGB input image

Fig 3: Gray image

Three different pixels—Red, Green, and Blue—make up the RGB image. When an RGB image is transformed into a grayscale image, the strength of each pixel can be determined using an equation based on the RGB image's pixel values

$$I_Y = 0.2989 \times F_R + 0.5870 \times F_G + 0.1140 \times F_B(1) \qquad (1)$$

Where IY is the intensity of related grey level pictures of an RGB image and FR, FG, and FB are the intensities of R, G, and B components, respectively.

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1.2 Skew Estimation and Correction

The accurate character segregation and identification are strongly affected by the skewed license plate [6]. An efficient method for license plate skew correction is needed to resolve the problem. Radon Transfer can be used to estimate the skew. By rotating the entered image by the tilt estimate step's acquired angle θ, the skew is corrected.

The estimate of an image by the specified angles may be computed by applying the Radon Transform on an image f (x, y) for a specific number of angles. A subsequent estimate, also known as a Line Integral, is a summing of the intensities of pixels in each direction. An outcome is image R(r,q).

This may be recorded mathematically by defining

$\rho = x \text{ Cs}\,\theta + y \sin\theta$

After which the Radon Transform may be recorded as

$$R(\rho,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y,)\,\delta\,(\rho - x\cos\theta + y\sin\theta)\,dxdy$$

In which, δ(·) is the Dirac Delta Function.

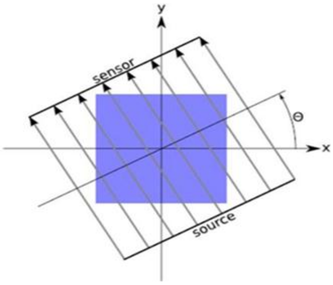

Fig. 4: Body turned around center of object

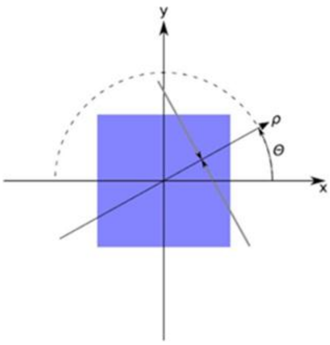

Fig. 5: P-axis marks are summed at R(P, θ)

The specified amount of Line Integrals can be used as an estimate for this function. The Radon Function computes the Line Integrals along rays that follow a predetermined path from multiple sources. One unit pixel separates each of the beams. The Radon Function uses numerous comparable ray predictions of a picture after several angles by rotating the original about the middle of the image to represent it.

The Source & Sensor entrapment is turned around the midpoint of the body presented in figure 4. For every angle ρ, the intensity of rays from source goes over is accrued next to the sensor. It is iterated by a given number of angels, typically after the angle 1800 is not compressed, meanwhile result may be the same to angel 00. From every angle θ and distance ρ the intensity of the matter a ray vertical to the ρ axis intersects are added up at the R (ρ, θ) presented in figure 5. The white mark is the distance from the mid and the angle upon which the entire of strengths in the image summits. It is thus the angle formed by the line with the location.

The midway of the body shown in figure 4 is where the Source & Sensor entrapment is located. The intensity of the rays from the source that pass across the sensor are accumulated for each angle. A predetermined number of angels repeat it, usually after. Angle 180^0 is not compressed, yet the result can be identical to that of angle 0^0. The R (ρ, θ) shown in figure 5 represents the point of intersection where the intensity of the object is summed up from every angle and distance. The white mark indicates the angle and distance from the center at which all of the image's strengths peak. Thus, it is the angle created by the location and the line.

I have used the Radon Function with this combination to calculate the Radon Transform of an image for the angles shown in the vector.

$$[R, xp] = radon\ (I, \theta)$$

The Radon Transform for each angle θ in is presented by the columns of R. The comparable coordinates along the x-axis are represented in the vector xp. The skew angle is calculated by constructing a matrix analysis of the obtained lines and deter-mining the angle of the highest visible line on the imageshown in figure 6.

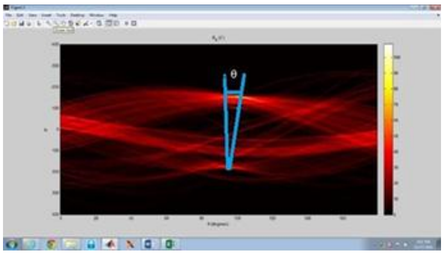

Fig.6: Skew angle estimated by Radon Transfer

Fig.7: Image rotated by the angle estimated

The image is rotated using the estimated angle shown in figure 7.

1.3 Dilation Of an Image

The method of Dilation [7] is an inventive technique for improving a certain image by filling in holes within the image, sharpening the edges of the objects inside the image, and connecting broken lines. The greatest value of each pixel that has entered the pixel's proximity contributes up the amount of the output pixel. If any of the pixel values in the binary image are set to 1, the output pixel is also set to 1.

The main result of the operator on a grayscale image is to gradually widen the borders of places where foreground pixels (often white pixels) are present. As a result, Foreground Pixels areas grow in size while the holes inside them get smaller. Figure 8 displays a dilated image.

ISSN: 2094-0343
2326-9865

Fig.8: Dilated image

Fig.9: Eroded image

The world that creates a pixel has the smallest value of all the pixels that are nearby. If any of the pixels in a binary image are set to 0, the output pixel is also set to 0.

In the field of mathematical morphology, erosion and dilation are important operators. It is typically used with binary images, but it may also be used with grayscale images to complete matrices using a variety of procedures. The operator on a binary image produces the simple result of erasing the edges of regions of foreground pixels, usually white pixels. As a result, Foreground Pixel portions shrink in size, and holes appear in previously smaller regions. Figure 9 shows an image that has been eroded.

The Erosion of *f* by *b* is similarly given by

$$\ldots = \underset{\ldots \in \ldots}{\text{infimum}}[\ldots - \ldots(\ldots - \ldots)]$$

The image will typically turn black when subjected to grayscale erosion with a flat diskette-shaped shaping component. Black areas surrounding by bright areas in-crease in size, and bright areas surrounded by dark areas contract in size. As little brilliant areas in photos are eroded down to the nearby strength value, they disappear, and minor dim spots enlarge. Areas of generally even intensity will be relatively untouched, excluding their boundaries, whereas regions in the image where the intensity fluctuates quickly will be the most visible locations for the result.

1.4 Horizontal and Vertical edge Processing

The image's boundaries appeared as two large breaks. A histogram is a graph that displays quantities of a varying amount across a defined series. The Number Plate Detection Algorithm uses horizontal and vertical histograms, which are equivalent to column- and row-wise histograms. The variations in Gray Values between neighbor-ing pixels in an image are added by those histograms, both column- and row-wise. The first computation of the horizontal histogram during the preceding stage is shown in figure 10.

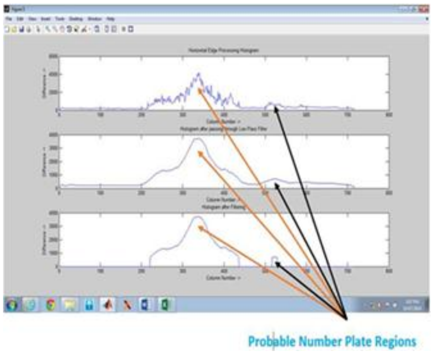

Fig. 10: Horizontal Histogram

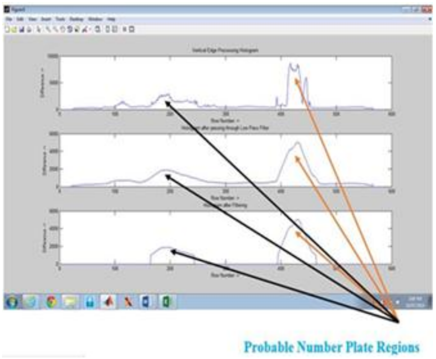

Fig. 11: Vertical Histogram

A horizontal histogram is created by repeating the technique over each column of the image. In each column, the procedure normally starts at the second pixel from the top. The difference between the second and the first pixel is calculated. Let's mention the distinction. The process will then descend to calculate the variance between the third and second pixels. This continues until the end of the column and computes the total addition of variances Amongst adjacent pixels.

The method used to find the vertical histogram shown in figure 11 is the same. In this scenario, rows take the role of columns in handling. When the Histograms are greater than the Low-Pass Digital Filter, the filter is used to remove unneeded portions of an image.

When the Histograms are exceeded over Low-Pass Digital Filter, filter is employed for eliminating unwarranted regions of an image. Within the situation, unnecessary regions are Rows & Columns have less Histogram values.

Rows and columns that aren't necessary in the situation have lower histogram values.

The Less Histogram estimate indicates that a tiny portion of the image shows exceedingly minute differences between nearby pixels. In regions where the number-plate is a part of a straightforward environment with alphanumeric letters, the varia-tion between neighboring pixels, especially between the margins of the characters and the number plate, can be extremely large.

The Histogram value for this portion of the picture is therefore too high. Thus, an extreme horizontal and vertical histogram reveals the region where a license plate has probably been. The least useful components are thus no longer required. Such elements are eliminated from a picture by employing a Dynamic Threshold. The mean value of a histogram corresponds to the dynamic threshold in this procedure.

The Dynamic Threshold succeeds each Horizontal & Vertical Histogram across a filter separately. The procedure's output isa histogram that shows regions with a high likelihood of including a number plate.

1.5 Segmentation

Once the license plate has been identified, segmentation is completed [10]. As previously mentioned, a license plate has places with significant intensity deviation. The next step is to identify all of the locations in a picture that have a good chance of containing a license plate.

The coordinates of all such potential places were stored in an array. By using the Line Scanning Technique, Character Segmentation is done effectively. Figure 12 below displays the obtained picture indicating the likely locations for license plate regions.

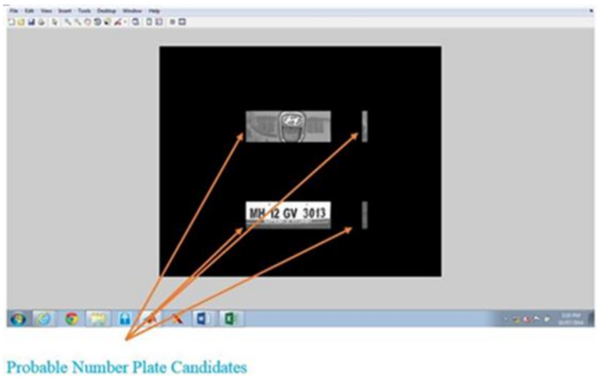

Fig. 12: Probable License Plate Areas

This procedure was confirmed by various intake images containing Resolution changing of 680×480 upto1600×1200 pixels. Images including vehicles with various colors as well as changing strength of illumination. Using this type of image, procedure properly identified Number Plate. Figure 13 below displays the extracted license plate region.

Fig. 13: Location of License Plate

The same procedure had been tested upon images containing Number Plate associated with definite angle (appx. 8-100) at Horizontal Axis. Although by these types of images, Number Plates were identified effectively [12]. Erosion is identical to the procedure of Dilation, but at this juncture pixels were transformed into white. This destroys object borders as well as separates linkages, if the size of constituting com-ponent is larger than the joining pixel.

The effectiveness of this technique was demonstrated by a variety of incoming photographs with resolutions ranging from 680×480 upto1600×1200 pixels. Images featuring cars in a range of colors and with varying light levels. This kind of pictureallowed the program to correctly identify the number

plate. The similar process was tested on photos of license plates with a certain angle (about 8–100) at the horizontal axis.

2. Results

Here, the recognition of LP from three different perspectives, such as two steps away from the license plate and four steps away, is taken into account to determine the entire recognition rate of the CLPR system.

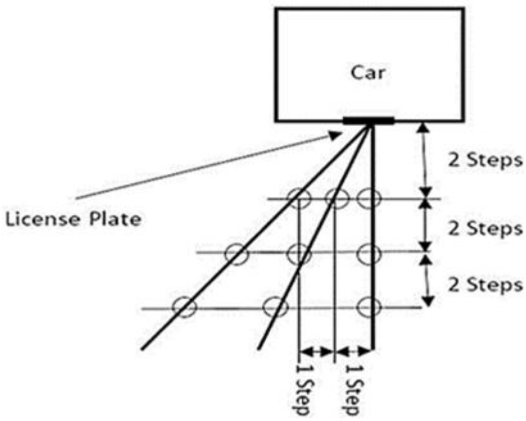

Fig. 14: View Points of License Plate (1 Step=60 cm)

View Point of License Plate	Straight	1 Step Left	2 steps

			Left
2 Steps away from License Plate	X1	Y1	Z1
4 Steps away from License Plate	X2	Y2	Z2
6 Steps away from License Plate	X3	Y3	Z3
2 Steps away from License Plate	X1	Y1	Z1

Six steps are taken away from the license plate. Each of these three perspectives can be seen from three various angles, such as a straight view, a view from one step to the left of the LP position, and a view from two steps to the left of the LP position. Thus, nine distinct viewpoints in total are obtained, as shown in figure 14. The variables used for denoting different viewpoints mentioned above are tabulated in the

Table 1: Different viewpoints of LP

License Plate Localization Efficiency:

The License Plate Localization efficiency can be measured as the relation of the quantity of License Plates located correctly in connection with the total quantity of License Plates. It is given by the equation

$$\%License\ Plate\ localization\ efficiency = \frac{Successful\ samples}{Total\ no\ of\ samples} \times 100$$

The License Plate Localization Efficiency may be measured by the above equation for the various viewpoints and the results are charted in the table 2.

View Point	**Z1**	**Z2**	**Z3**
Sample Images	62	62	60
Located License Plates	62	62	58
Efficiency (%)	100	100	96.67

Table 2: License Plate Localization Efficiencymeasurement readings

3. Conclusions

In this research, a novel approach to the License Plate Recognition (LPR) system and related algorithms are described, and experiments with them are conducted. In this work, the localization of license plates using images of vehicles is given more emphasis. The study is done using the database of more than 600 images.

View Point	Total Samples
Sample Images	554
Located License Plates	552
Efficiency (%)	99.63

Table 3: License Plate Localization Overall Efficiency

For locating the License Plate area, there must be an accurate edge concerning to the License Plate border along with the car within the background, for that Sobel Operator is employed to discover the edge.

4. Acknowledgments

Our sincere thanks to Dr. Padmakar Kelkar and Mr. Sudarshan Natu for contribution towards development of the algorithm.

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