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LPR System Design for Domestic Security

Naveenraj. M[1], Sneha Shree. S[2], Soundariya Devi. K[3], Sriyasika. K[4] & Vengateswari. K. M[5]
[1]Assitant Professor, Department of ECE, Kathir College of Engineering
[2,3,4,5]Department of ECE, Kathir College of Engineering

Abstract: *Licenseplate identification is a challenging area, which is in contrast with the traditional practice of monitoring the vehicles manually. In this paper, License Plate Recognition system uses Image Processing and Character recognition for obtaining the desired information. The purpose of this system is to develop a real time applications which recognize the license plate from cars at the gate for example entrance of parking area or border crossing. The captured video is processed using MATLAB 2013a and the recognized digits are compared with the database and displayed using interface usingHough transform, sobel edge detection and segmentation process on the input. The Arduino board is then initiated from the signal generated by MATLAB for mechanical operation [gate opening].*

1. Introduction

License plate recognition(LPR) systems have received a lot of attention in recent days. Much research has been done on different types of license plates. And the resultswere inappropriate due lack of standardization among different license plates (i.e., the dimension and the layout of the license plates). This paper gives an overview of the research carried out so far in this area and the techniques adopted in developing an LPR system in lieu of the following four stages:

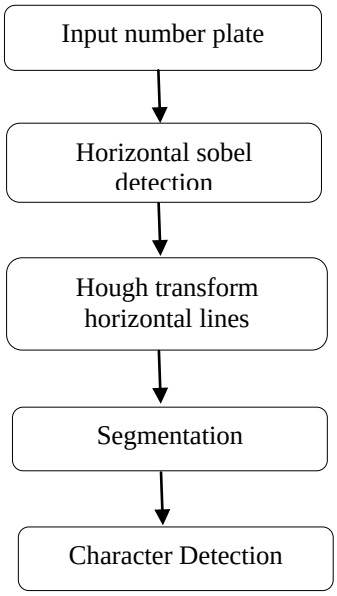
i. Image Acquisition
ii. License plate extraction
iii. License plate segmentation
iv. License plate recognition phases

Before performing the development on the image, pre-processing has to performed on the input The main aim of pre-processing in LPR systems is to remove unwanted distortions present in the image.

2. Proposed Method

The proposed method is used for implementation on license plates for recognition of the information present in it. This method uses an input image of bmp format as it has a header, optional color lookup area and a pixel data area for efficient extraction.

The various stages of number plate recognition system is given as,



The information from the input image is first processed using Sobel edge detection which detects all the edges present in the image and then Hough transform is applied for the detection of horizontal lines present in the images. After the successful detection using Hough transform, the letters present in the image is segmented by finding the end points in the characters.

The alphanumeric characters arethen obtained by comparing it with the characters present in the database.

Input Image

3. Edge detection

Edge detection is a process of localizing pixel intensity transitions. The edge detection is used for object recognition, target tracking, segmentation. So this becomes very important part of image processing. There are many edge detection methods are available such as Sobel, Prewitt, Roberts and Canny. They are mainly used for detection transitions in an image. They are mainly proposed to determine the best gradient operator to detect sharp intensity variations.

In this paper we use sobel edgedetection method because of its simplicity and common uses.Normally, edges are local changes of intensity in an image. Edges occur on the boundary of an image. The gradient edge detection method is used to find the best gradient intensity. The gradient is a vector which has both direction and magnitude.

$$\nabla f = \begin{pmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{pmatrix}$$

$$magn(\nabla f) = \sqrt{(\frac{\partial f}{\partial x})^2 + (\frac{\partial f}{\partial y})^2} = \sqrt{M_x{}^2 + M_y{}^2}$$

$$dir(\nabla f) = \tan^{-1}(M_y/M_x)$$

The approximated gradient is given by,

$$magn(\nabla f) \approx |M_x| + |M_y|$$

The finite differences of the estimated gradient are,

$$\frac{\partial f}{\partial x} = \lim_{h \to 0} \frac{f(x+h, y) - f(x, y)}{h}$$

$$\frac{\partial f}{\partial y} = \lim_{h \to 0} \frac{f(x, y+h) - f(x, y)}{h}$$

Then, the estimated gradient can be approximated as,

$$\frac{\partial f}{\partial x} = \frac{f(x+h_x, y) - f(x, y)}{h_y} = f(x+1, y) - f(x, y), \quad (h_x=1)$$

$$\frac{\partial f}{\partial y} = \frac{f(x, y+h_y) - f(x, y)}{h_y} = f(x, y+1) - f(x, y), \quad (h_y=1)$$

For example, let us consider the arrangement of pixels (i,j)

$$\begin{matrix} a_0 & a_1 & a_2 \\ a_7 & [i, j] & a_3 \\ a_6 & a_5 & a_4 \end{matrix}$$

The partial derivatives are,

$$M_x = (a_2 + ca_3 + a_4) - (a_0 + ca_7 + a_6)$$
$$M_y = (a_6 + ca_5 + a_4) - (a_0 + ca_1 + a_2)$$

The constant c implies the prominence given to the pixels near the center of the mask.

For example c=2, The sobel operator is represented as,

$$M_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad M_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

(Note: Mx and M_y are approximations at(i, j))

The sobel edge detection is applied to the input number plate and the resulting image is shown in fig.

Edge Detected Image

4. Hough transform

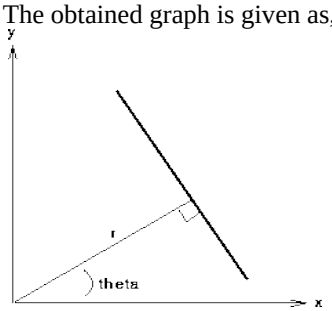
Hough transform is a unique technique for detection of global parameters of local measurements. The main idea behind Hough transform is that the line detection process has

contribution to all local measurements. The general equation for describing the line parameters is given as:

$$x\cos\theta + y\sin\theta = r$$

where r is the length of a normal from the origin to this line and θ is the orientation of r with respect to the X-axis.

In image analysis process any point in the line (x,y) is a constant and knownas it is obtained from edge detection process, while r and θ are unknown. A graph plotted for (r,θ) we obtain a curve which is the point to curve representation for Hough transform. The obtained graph is given as,



Representation of point to curve transform

The obtained result givesa clear evidence that the input image has a set of straight lines in the accumulator array that indicates the shape of the information present in the bmp image.

Hough transform is applied to the number plate image and the output is obtained as,

Hough transform applied on input image

5. Segmentation

Image segmentation is the process of splitting of an image into regions or categories, which correspond to different objects or parts of objects in the image. Every pixel in an image belongs to one of these two categories:

- Pixels in the same category have similar grayscale of multivariate values and they form a connected region.
- The neighbouring pixels which are in different regions have dissimilar values.

Image segmentation is an essential preliminary step in most pattern recognition and scene analysis problems. The main goal of image segmentation is to divide an image into parts that have a strong correlation with objects or areas of the real world contained in the image. There are many different algorithms to achieve image segmentation. The choice of one segmentation algorithm over another is dictated mostly by the peculiar characteristic of the problem being considered. In this work, the segmentation algorithm will be based in the fusion of the Hough transform.

In the segmentation of plate characters, number plate is segmented into its constituent parts obtaining the characters individually. The step is to cut the plate characters. It is done by finding starting and end points of characters in horizontal direction.

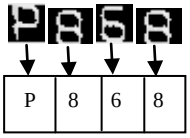
The individual characters cut from the plate are as follows in fig.

(a) (b) (c) (d)

Segmented Image

6. Character Detection

Optical Character Recognition(OCR) is a method which uses Electronic conversion of images which is in digital format into text format. The characters in the image are compared with the text stored in the database.



Detected Text

The obtained text is compared with the database and and if the text matches a signal is sent to the board which activates the mechanical motion ie., opening of the gate. If the text does not match if alerts the security by providing a buzzer sound for security purpose.

The efficiency obtained from the proposed method is more than 96% and the comparison of efficiency with the past research is given as,

YEAR/MONTH	% EFFICIENCY
2003	95
2005NOV	92.57
2008JUNE	95
2009SEPT	93.1
2010	98
2011JULY	94
2011JULY	95

2011DEC	89.74
2012APRL	93
2012EPT	93.2
2016	96+

Efficiency comparison

7. Conclusion

The process of vehicle number plate recognition requires very high accuracy for reliable security purposes. Though we have achieved an accuracy of 98% by optimizing various parameters it is required for the task of monitoring automobiles for home land security and an accuracy of 100% cannot be compromised with this method. Therefore to achieve this, further optimization is required which can obtained by using digitized cameras and efficient sensors.

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