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Automatic License Plate Recognition (ALPR) System Using Optical Character Recognition

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Abstract: Intelligence surveillance is an important commodity in traffic based system. Automatic License Plate Recognition (ALPR) is a challenging area of research. This works deals with problems related to artificial intelligence , neural networks and machine vision in the construction of an automatic license recognition (ALPR)system. These intelligence system helps in traffic monitoring during rush hours, road safety and commercial applications like car parking lots and law enforcements .In this paper a license plate recognition system is proposed which uses captured digital image of front or rear of the vehicles and can be easily applied to commercials car park systems to access the parking spaces and also it prevent car theft issues.

Keywords: ALPR: Automatic license plate recognition, Sobel operators, License plate region, Bounding box and OCR: Optical character recognition

I. INTRODUCTION

Basically an automatic license localization and recognition (ALPR) system has tree modules: license plate localization, character segmentations and optical character recognition modules. Firstly, license plate localization from vehicles. Secondly, character segmentation from localized plate . Finally, optical character recognition of extracted characters. The most common solutions to license plate recognition in digital images are through the implementation of edge extraction , morphological operators and Sobel operators .Sobel operators for edge detection gives positive effects of image .The localization of license plate via morphological based approach is not susceptible to noise but it is very slow in execution. [2]

After localization of the license plate comes the character segmentation process. Commonly, character segmentation process is based on histogram and thresholding.

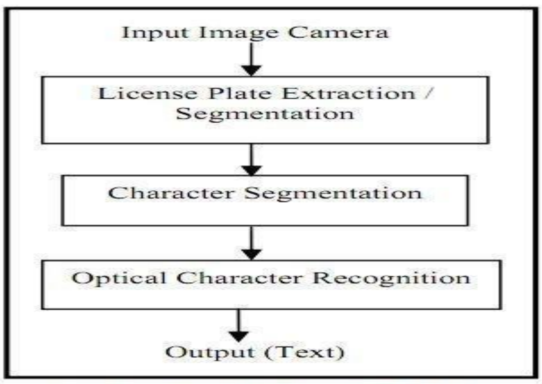

Fig. 1. Flowchart of a Typical ALPR System

Types of License Plate Recognition System:

1. Online ALPR system: In online ALPR system, the localization and interpretation of license plates take place instantaneously from the incoming video frames, enabling real time tracking through the surveillance camera.

2. Offline ALPR system: An offline ALPR system is contrast, captures the vehicle image and stores them in a centralized data server for further processing, i.e. for interpretation of vehicle license plates.

II. CHALLENGES IN ALPR

In the developed countries the rules of license plate is strictly maintained, for example size, color of plate, font/size/color of each character, spacing between the characters etc. Some of the images of license plates of developed countries are shown below in figure 2 [5].

But in India, there is no set of rules or standards for license plate across any states. This makes localization and subsequent recognition of license plates extremely difficult. Moreover, in India license plates are often written in multiple scripts, colors and sizes. Some of the typical Indian license plates with variations in shape, size, and colors are shown below in figure 3 [5].

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Fig. 2.1

Automatic license plate recognition has two major requirements:

1. Quality of license plate recognition algorithms
2. Quality of image acquisition

Basically one LPR software can read plates from one country only because of the geometrical structures of the plates and the orientation, fonts and syntax are the important part of LPR system.

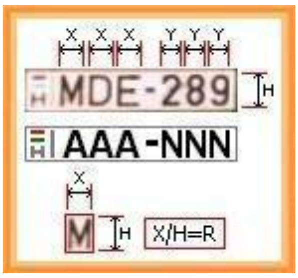

Fig.2.2 Plae geometry and basic syntax

Image acquisition technique determines the captured image quality of the license plate with which the detection algorithm have to work. Better the quality of the acquired images, higher is the accuracy one can achieve.

Low spatial resolution (too small characters on the plate)

Blurred image

Low contrast

Overexposure

Bad lighting conditions (shadow and strong light)

High distortion

A good captured image must have following properties :

1. Good spatial resolution
2. Good sharpness
3. High contrast
4. Adequate lighting conditions
5. Decent angle of views

Some challenging images obtained from (http://www.platerecognition.info/1102.htm) are shown below:

III. AN OVERVIEW OF THE SYSTEM

The preprocessing techniques for localization of the license plate:

1.Converson to grey scale : The red , green and blue components are separated from the 24-bit color value of each pixel(i , j) to calculate the 8 bit gray value using the formula[7[.

Gray(i,j) = 0.59*R(i,j) +0.30*G(i,j)+0.11*B(i,j)

2. Median filtering: It is a non linear filter, which is used to replace the gray value of each pixels with the median of the gray values of its neighbors .This operation helps in removing salt pepper noise from the image .

3. Enhancing the contrast:

Contrast of each image can be enhanced through the histogram equalization technique. There are total of 256 numbers of gray levels that are used for stretching the contrast. Let the total no. of pixels in an image be n and the no. of pixels having gray level be k .Then the probability that a gray level k will be occurred is, PK= nk/N The stretched gray level Sk is calculated as follows:

$$S_k = \sum_{j=0}^{k} \frac{n_j}{N} \times 255$$

Here, 255 is the maximum gray level present in the enhanced pictures. Screenshots of processing are below:

Figure 1.

(a) Grayscale Image (b)Noise Reduced Image

(c) Contrast Enhanced Image

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Localization of License Plate

This technique is used to identify the potential license plate region from the given image. The main objective is to localize the license plate region from the images of the vehicle that are captured in the camera. Quality of the images plays an important role.

1. Edge detection

Edges help to characterize the boundaries and therefore are a problem of fundamental importance while processing the image. Detecting the edges of an image significantly reduces the amount of data and it also helps out in filtering out the useless information and protecting important information. Mainly, to perform edge detection two categories are formed , gradient and laplacian.

2. Sobel Filter

It helps to perform a 2-Dimensional spatial gradient measurement on an image. Generally it is used to find the approximate absolute gradient magnitude at each point on an input grayscale image. The sobel detector make use of a pair of 3x3 convolution masks, one estimates the gradient in the x-direction and the other estimates the gradient in the y direction. The actual Sobel masks are shown below[6].

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

The magnitude of the gradient is calculated by using the formula:

In this present work, we have explored this kind of phenomenon to find the license plate region inside the image. The vertical edge at point (x,y) can be found using the following formula:

$$gradV\ (y,x) = \sqrt{\left(\sum_{m=-1}^{+1}\sum_{n=-1}^{+1} V\_mask\ (n,m)\ img\_contrast\ (y+n, x+m)/4\right)^2}$$

Here , V_mask is the Sobel’s mask used for vertical edge detection as given below:

$$V\_mask = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

The result of edge detection after binarization is applie in it is shown in figure below:

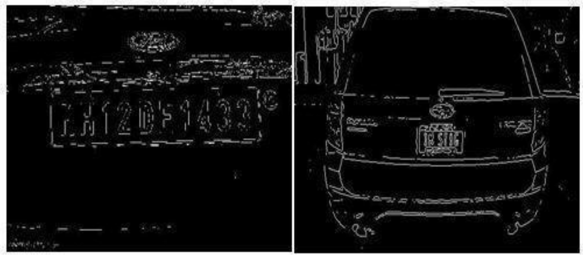

Figure 2 : After applying Sobel filter and binarizing the image

3.Connected components

1. 4-Connected : These pixels are connected both horizontally and vertically.In terms of pixel coordinates , every pixel having the coordinates or is connected to pixel at (x,y)[7].

2. 8-Connected : These pixels are connected horizontally, vertically and also diagonally[7]. In addition , to the 4-Connected pixels, each pixel and each connected component is labelled.

4. Bounding box

The minimum or the smallest bounding or the enclosing box for any point set in N dimensions is the box with the smallest measure within which all points lie. The minimum bounding box of any point set is same as the minimum bounding box of its convex hull.[8].

Figure 3 : Bounding boxes in the image

5.Selecting the best Bounding boxes

Following properties should be kept in mind while selecting best bounding boxes:

1. Contrast present in the bounding box
2. Aspect Ratio
3. Width of license plate
4. Total numbers of pixels in license plate

Figure 4: The Bounding Box satisfying the properties of licence plate

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6.Cropping the Bounding Box
In this the coordinates of the bounding box are noted and the box is cropped from the image.

Figure 5 :Shows the cropped bounding box from the image.

The character segmentation process acts as a bribetween the license plate lacalization and optical character recognition. It's main function is to segment he characters in the selected candidate region such that each character can be sent to the optical character recognition module individually foe recognition.
1. Processing stage
In this stage we ensure that there is no unwanted characters or graphics on the license plate. Then scanning of the plate is carried out vertically and horizontally.

Extracted license plate

The extracted image is a colored JPEG file from which only binary images are required. By binarization of the image we get following image:

Resultant Binary Image

Inverted Binary Image

The binary image has certain unwanted areas that can hamper our recognition process. So, we use the concept of connected components to filter small areas out of the plate region.

Binarised Image Free from noise

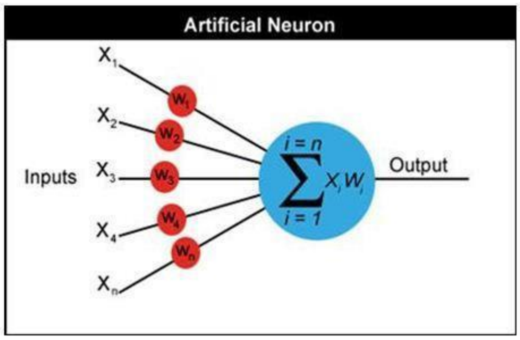
2. Segmentation of plate using horizontal projection
This projection is used to determine horizontal boundaries between segmented characters.[3]. Now, the redundant back grounds are removed. Lastly , the indivisual characters are extracted. These individual characters are then fed to the next step analysis whish is the final step called optical character recognition.

IV. OCR : OPTICAL CHARACTER RECOGNITION

The neural networks are typically made up of many artificial neurons. An artificial neuron is an analogy to biological neuron. It is simply electrinically modeled to thr biological neuron. The number of neurons that are used depend upon th task undergoing. Some ways are given as follows:

1.Feedforward network:
2.In this neural network each input into the neuron has its own weight associated with it. A weight is simply a floating point number and it is these that we adjust when we come to train the network.

The weight can be both positive or negative. A neuron can take any no. of input between 1 to n.The input therefore is represented as x1,x2,x3….xn. The corresponding weights of the inputs is given as w1,w2,w3,….wn. The weighted sum of the links is calculated as follows:
3.A= x1w1+x2w2+x3w3+……..+xnwn
4.Where A is the activation value.



5.Back Propogation Network Algorithm
This networks learns by example Various sets of datasets are provided as input. The various inputs provided helps the network to calculate and recalclate the networks weight vale sa that when the networks is trained it can give the reqiured output.

V. APPLICATIONS

1.Automatic ticketing of vehicles at car parking facilities.
2.Tracking vehicles during traffic signal violations and related applications with huge savings of human energy and cost.

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VI. CONCLUSION

1. for localization of the license plate recognition there should be proper edge in between the license plate boundary and the car in the background for the Sobel operator to detect the edge. The camera should be present at a particular distance from the license plate so that the range in which the totalnumber of pixels lie inside the license plate region remain constant.
2. For the process of character segmentation we observed that if there is no clear boundary between each character, segmentation cannot be carried out successfully. Also, fancy fonts create a hindrance to successful segmntation.

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