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Review On Car-License-Plate Detection Systems

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***Abstract*— In this paper we have reviewed and analyzed different car-license-plate detection and recognition technique. We have reviewed different image processing Edge Detection techniques and recognition technique like Sobel operator, Canny operator, ANN, BPNN, Template matching. We have also represented analysis of these techniques in the form of table considering different factors of Edge Detection and recognition like visual quality, security, robustness and computational complexity.

It is concluded that in edge detection techniques vertical edge detection technique are best with some factors like processing time, accuracy, while in recognition technique BPNN are best for some factors like execution speed or other image processing operations and security. The visual quality and computational complexity are common factors for both the technique.

Keywords— *Car-License-Plate Detection, Vertical Edge Detection Algorithm, Edge Detection, License Plate, Adaptive Thresholding*

I. INTRODUCTION

The purpose of this paper is to provide a systematic survey of existing CLPD research by categorizing existing methods according to the features they used, by analyzing the advantages and disadvantages of these features, and by comparing them in terms of recognition performance and processing speed, and to open some issues for the future research.

The variations of the plate types or environments cause challenges in the detection and recognition of license plates. They are summarized as follows:

1) Location: Plates exist in different locations of an image.
2) Quantity: An image may contain no or many plates.
3) Size: Plates may have different sizes due to the camera distance and the zoom factor.
4) Color: Plates may have various characters and background colors due to different plate types or capturing devices.
5) Font: Plates of different nations may be written in different fonts and language.
6) Other: In addition to characters, a plate may contain frames and screws.

II. RELATED METHODS AND DESCRIPTION

A. *LICENSE PLATE DETECTION* TECHNIQUE

1. SOBEL OPERATOR:

It is one of the most useful techniques in image processing very popular in image processing as shown in the application of License Plate Detection[2]. Sobel Operator is a classical edge detector. With the License Plate of small integer valued filter into vertical and horizontal directions by using of (3x3) mask to convolve the image [8]. The mask preferred is applied to the whole image and this mask process square pixel at a time on image. It represents a two dimensional spatial gradient measurement. Due to small integer values the Sobel operator is relatively expensive.

Advantages:

1. The main advantage of Sobel operator is its simplicity which is because of the approximate gradient calculation.
2. Suitable for simple images.
3. Massive data Communication and data transfer.

Disadvantages:

2. The major disadvantage of Sobel operator was the signal to noise ratio. With the increase in noise the gradient magnitude of the edges also degrades which produces inaccurate results.

3. CANNY OPERATOR:

First of all convert the RGB image to gray scale image and then remove noise from the image then apply the canny edge detector on the image. The canny edge detection provides an exact detection of the License Plate and provides better localization with very minute difference

within the actual and provided edge [11]. The boundary of the object is represented by edges. Edges are also used to identify areas and shapes of the object.

Advantages:
1. Suitable for simple as well as complex images
2. Adaptive in nature
3. Less Sensitive to noise
4. Better detection specially in noise conditions

Disadvantages:
1. Complex and Time consuming.

4. ROBERT OPERATOR

It computes the 2-D spatial gradient measurement and also highlights the high spatial gradient region corresponds to edges. It consists of a 2x2 convolution mask. In [12] it detects the LICENSE PLATE of the input image by down sampling. In [13] Robert operator first starts to detect the vertical edges of the input image and then it filters the image to get its horizontal edges.

Advantages:
1. Simple Detection of edges and their orientations.

Disadvantages:
1. Sensitive to noise
2. Inaccurate

3. LAPLACIAN EDGE DETECTION:

The Laplacian is a 2D isotropic measure of the 2nd spatial derivative of an image. It is similar to as Sobel operator. The only difference among them is that the Laplacian uses only one mask for both horizontal and vertical direction as in [13,14]. The mask approximates second derivate of the image and is very sensitive to noise. Noise reduction LOG is used which first smoothens the image with Gaussian filter and then applies Laplacian operator [13].

Advantages:
1. Finding the correct places of edges
2. Testing wider area around the pixel

Disadvantages:
1. Malfunctioning at corners, curves and where the gray level intensity function varies
2. Not finding the orientation of edge because of using the Laplacian filter

4. MORPHOLOGICAL:

In primarily edges of the images are detected first, then the vertical projection of the edge image is detected, candidate regions are selected by means of these vertical edges in these structures. Compaction factor has been advised by the authors in order to avoid this problem[2]. The vertical edges of the License Plate are less in numbers but become dominant in the case of structure. By applying method brightness of pixels in rows is found and maximum candidate area is given by the local maximum inside. Using that method plates can be easily extracted. The morphological binary map is first generated by obtaining the difference between closing and opening image. Connected components for each candidate region are generated and then each connected component is reshaped to have smooth boundaries[21]. The dominant local binary pattern is used to find the intensity variation around the transition pixel. The boundaries of the detected text regions are localized accurately using the projection of text pixels in the morphological binary map.

Advantages:
1. High processing speed

Disadvantages:
1. Morphology is more difficult

5. HISTOGRAM BASED SLIDING CONCENTRIC WINDOW:

In [22] SCW used for faster detection of region of interest (ROI), SCW operates in natural background and presents an algorithm to handle plates of various sizes. The algorithm steps are as follows:

- Create two concentric windows for the pixel of the image.
- Calculate the standard deviation of the pixels in the window.
- First standard deviation of window if the ratio is greater than the threshold then the central pixel of windows is considered as vertical and horizontal region. Set the pixel value to 1 if it exceeds the threshold value otherwise set to 0. Through this algorithm License Plate region is authenticated then the HSI color model is used to authenticate the candidate region. HSI color space identifies the color of Different objects. In the image processing HSI is used in histogram operations and by this License Plate region is extracted based on colors and histograms. Then finally it is verified by taking its vertical and horizontal histogram positioning whether this License Plate or not? In short input image is a gray level image and the image after SCW is a binary image and after finding horizontal and vertical regions connected components are found to detect the candidate region and then by HIS color spacing candidate region is authenticated and the License Plate is extracted and through histogram positioning it is verified that candidate region is License Plate.
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- **Advantages:**

1. Minimal maintenance
2. Easy to implement

Disadvantages:
1. Large memory requirement
2. Slightly slower

6. VERTICAL EDGE DETECTION ALGORITHM:

The vertical edge detection algorithm is used to distinguish the plate detail region, particularly the beginning and the end of each character. Therefore, the plate details will be easily detected, and the character recognition process will be done faster. After thresholding and ULEA processes, the image will only have black and white regions, and the VEDA is processing these regions. The idea of the VEDA concentrates on intersections of black–white and white–black. A 2 × 4 mask is proposed for this process, as shown in Fig., where x and y represent rows and columns of the image, respectively. The center pixel of the mask is located at points (0, 1) and (1, 1). By moving the mask from left to right, the black–white regions will be found. Therefore, the last two black pixels will only be kept. Similarly, the first black pixel in the case of white–black regions will be kept. This process is performed for both of the edges at the left and right sides of the object-of-interest. The first edge can have a black-pixel width of 2

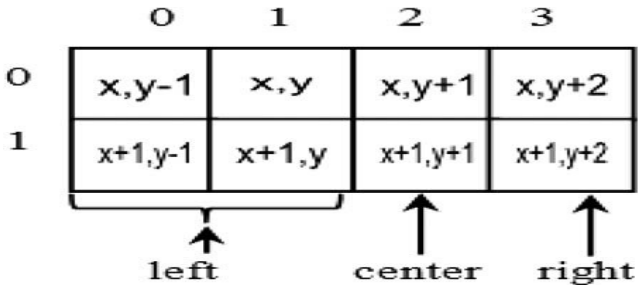

Fig. Design of proposed mask

Advantages:
1. Less processing time
2. More accurate

Disadvantages:
1. Complex analysis is needed.

B.RECOGNITION TECHNIQUES

a) Artificial Neural Network (ANN)

Artificial neural networks based on Kohonen's self-organized feature maps is implemented in [5] to handle noisy, deformed, broken, or incomplete characters acquired from LPs that were bent and/or tilted with respect to the camera. This method focused on accuracy at the cost of increased complexity and execution speed. The success rate for character identification, in a large set of 1061 LPs in various viewpoints (combinations of angle and distance) is around 95.6%.

Advantages:
1. Requiring less formal statistical training.
2. Ability to implicitly detect complex nonlinear relationships between dependent and independent variables.
3. Ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms.

Disadvantages:
1. Greater computational time.
2. Proneness to over fitting and the empirical nature of model development.

1. Probabilistic Neural Networks (PNN):

Probabilistic Neural Networks (PNNs) are introduced in the neural network literature by Anagnostopoulos *et al.* [4]. These types of neural networks can be designed and trained faster, as the hidden-layer neurons are defined by the number of the training patterns and are only trained once. PNN for LPR is first introduced in an early version of an LPR system where two PNNs, i.e., one for alphabet recognition and the other for number recognition, are trained and tested. The recognition rates reported in the literature are very encouraging when PNNs are trained and tested in noisy, tilted, and degraded patterns. The Optical Character Recognition (OCR) system is a two layer PNN with a topology of 108-180-36 nodes, whose performance for entire plate recognition reached 89.1%.

Advantages:
Fast training process Orders of magnitude faster than Back propagation An inherently parallel structure Guaranteed to converge to an optimal classifier as the size of the representative training set increases no local minima issues Training samples can be added or removed without extensive retraining.

Disadvantages:
1. Not as general as back propagation.
2. Large memory requirements .
3. Slow execution of the network Requires a representative training set Even more so than other types of NN's.

2. Back Propagation Neural Network(BPNN):

Huang et al. [1] uses back propagation neural network (BPNN) for recognizing characters. The 26 vertical and 50 horizontal projections of the normalized 26×50 pixel license plate image are fed into 76 input nodes of BPNN. This network also comprises of 85 hidden nodes and 6 output nodes. Most license plate characters are successfully recognized by BPNN. However, characters such as B and 8, 1 and I, 8 and B, and O and D may be hard to distinguish using the neural network. The most significant difference between the characters O and D lies at their upper and lower left corners. A straight line is posted to the character as the base line to respectively accumulate the number of white pixels at the upper and

lower left corners. The recognition rate is 97.3%.

Advantages:
1. Relatively simple implementation
2. Standard method and generally works well

Disadvantages:
1. Slow and inefficient
2. Can get stuck in local minima resulting in sub-optimal solutions

b) Support Vector Machine (SVM)

In [10], Support Vector Machine (SVM) is used for character recognition. Before training and testing, features are extracted using Local-Direction Contributivity Density (L-DCD) and Global-Direction Contributively Density (G-DCD). Compared to neural networks, SVM has less misclassification rate.

Advantages:
1. It has a regularization parameter, which makes the user think about avoiding over-fitting.

2. It uses the kernel trick, so you can build in expert knowledge about the problem via engineering the kernel.

3. An SVM is defined by a convex optimization problem (no local minima) for which there is efficient methods.

4. It is an approximation to a bound on the test error rate, and there is a substantial body of theory behind it which suggests it should be a good idea.

Disadvantages:

The disadvantages are that the theory only really covers the determination of the parameters for a given value of the regularization and kernel parameters and choice of kernel. In a way the SVM moves the problem of over-fitting from optimizing the parameters to model selection. Sadly kernel models can be quite sensitive to over-fitting the model selection criterions.

e) Template Matching

In [20], template matching method is used for character recognition. Each segmented character is matched with the stored template. Priority is assigned for each template. When matching is performed, first the highest priority template is compared and if a match occurs the lowest priority templates are ignored. Number templates are assigned higher priorities because chances of occurrences of alphabets are less than the numbers. Caner *et al.* in [3] used a Self Organizing Map (SOM) neural network to identify the characters. An ordinary SOM has the following two layers: 1) an input layer and 2) a computation layer. The computation layer has the processing units. The weight matrix of the SOM is calculated during the learning phase. The hardware designed calculates the hamming distance between the weight matrix of each neuron and the input image and makes a decision on the output character. The recognition rate is 90.93%.

Advantages:
1. More Flexible and effective
2. Easier to recognize
3. Cheap in cost

Disadvantages:
1. Rotation and scaling will cause poor matches.
2. Inefficient
3. Orientation-dependent

V. ANALYSIS

Sr.no	License plate detection technique	Accuracy	Time Required	Impleme-ntations
1	Sobel	Less	Medium	Simple
2	Canny	High	More	Complex
4	Histogram	Medium	Medium	Medium
5	Morphology	Medium	Less	Complex
6	VEDA	High	Less	Complex

CONCULSION

In this paper, we have reviewed and analyzed different edge detection and recognition techniques. We have reviewed different image processing Edge Detection techniques and recognition technique like Sobel operator, Canny operator, ANN, BPNN. We have also represented analysis of these techniques in the form of table considering different factors of Edge Detection and recognition like Accuracy,security,Time Requirement and computational complexity.

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