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Car License Plate Checking System Based on Neural Network

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Abstract: ***The proposed car number plate checking (detection) system plays an important role in Digital Image Processing. Car license checking system is a form of automatic vehicle identification. It is an image processing technology used to identify vehicle by only the car license plates. The proposed system consists of basic operations such as preprocessing and image conversion from RGB to Gray. Then, it segments the metallic car license plate part from the front view of car by region growing in the reduction of searching space for localizing the car license plate. And also it applies morphological operators on same image then extract plate region from image and then character segmentation is performed on extracted License Plate and these segmented characters are recognized using Neural Network. Car license plate checking system is developed using MATLAB. Experiments show that the proposed system can effectively and quickly capture the car vehicle image, detect and recognize, the car license plate whether it is in noisy data, lighting and slightly dark under complicated environment.***

Keywords: Region Growing, License Plate Checking, Morphological processing, Neural Network

1. Introduction

A number plate is the unique identification of a vehicle. Automatic Number Plate Recognition (ANPR) is designed to locate and recognize the number plate of a moving vehicle automatically. Today, the number of car vehicles grows rapidly, the traffic problems increase as well, for example, speeding, and running the red light, car crash, the vehicle monitoring and management system based on vehicle license plate recognition has been matured. Many big parking lots and major streets are using the Charge-coupled device (CCD) to carry on the vehicle monitoring and management. This system adapts the image recognition technique. This technology is used in various security purposes for finding stolen cars, traffic management system, in electronic toll collection, smuggling of cars, usage of cars in terrorist attacks, on the search of cars suspected of robbery and illegal activities. Because of the mentionable searching the suspected car, motorcar traffic control problem, vehicle tracking, car license plate recognition and management of the traffic has become major topics of modern traffic control system.

To solve these many problems, car license plate checking system has achieved a lot of attention for the research area. This system is a part of digital image processing which is broadly used to catch the car accident using car license plate checking system to identify the vehicle. A license plate is the unique identification of vehicles. The car license plate identification task is the challenging problems because of cropping the plate region from the whole car, nature of light and variety of noises. Mainly, the proposed system is to extract the car license plate region from the car vehicle's image using **Region Growing** method. It is the very important stage to get the real license plate location from vehicle image because of different car vehicles have license plate located on different position. And quality of image is also important part of the proposed system that preprocessing stage using the noise filter help to improve the image quality. Morphological operations are applied to the license plate image for the extraction the required features. In this proposed system uses opening and closing operation to extract the number plate and dilation and erosion to enhance the extracted number plate. The characters of the identified number plate region are segmented using **Regionprops** function of MATLAB. Regionprops method is used to obtain the bounding boxes of all characters in the number plate.

2. Related Works

The car license plate recognition system generally consist of three stages: car license plate localization, character extraction and recognition. The three stages of the systems are analyzed separately in literature review. In [1-2] a fuzzy based method was introduced using neural networks. Parul Shah et. al. [7] presents a novel algorithm for vehicle chassis number identification based on OCR using artificial neural network. This method gives considerably high value for correct identification rate along with zero wrong identification rate. Muhammad Tahir Qadri et. al. [9] presents automatic vehicle identification system. The OCR methods in this are sensitive to misalignment and to different sizes. Anuja P. Nagare [3] have developed a system to detect car license number plate. The detection process is divided into three steps, License Plate Detection / Extraction, Character Segmentation and Character Recognition. The proposed algorithm base on Sobel Operator is used for edge detection. After edge detection series of morphological operations are performed in order to detect the license plate. The character recognition was accomplished by using two Neural Network techniques for character recognition, one is Back Propagation Neural Network and other one is Learning Vector Quantization Neural Network. Their results are compared based upon their perfection in the character recognition. Sneha G. Patel [4] applied Sobel operator to extract the edge of objects in image; then the algorithm applies the dilation and erosion mathematical morphology of binary images to get the image smooth contour. The segmentation result which is sent forward to LP recognition stage will improve further processing's efficiency. Neural Network is used to recognize the license plate character. A. A. SAFI, M. AZAM, S. KIANI, N. DAUDPOTA **[5]** proposed real time analysis of a moving car in order to

extract important data. System detects and recognizes a license plate of the car registered in NWFP province of the Pakistan. B. Bhushan, S. Singh, R. Singla [8] proposed automatic number-plate recognition using Back error propagation. Kim [12] proposed the method based on vertical edge using Hough transform (HT) for extracting the license plate.

3. System Overview

The proposed car license plate recognition system generally consists of four stages: preprocessing, candidate region detection, character extraction and pattern recognition. The proposed system used median filter to remove the noise data and the region growing method to receive the required license plate. The required candidate region detection is a challenging problem in this area. Morphology is used to extract character features from the original license plate. Dilation is an operation that "grows" or "thickens" objects in a binary image. Character segmentation from the number plate region is the important step in this system, which influences the accuracy of character recognition significantly. The goal of this phase, given the license plate image, is to segment all the characters, without losing features of the characters using BPNN. A block diagram of the proposed system can be seen in Figure 1.

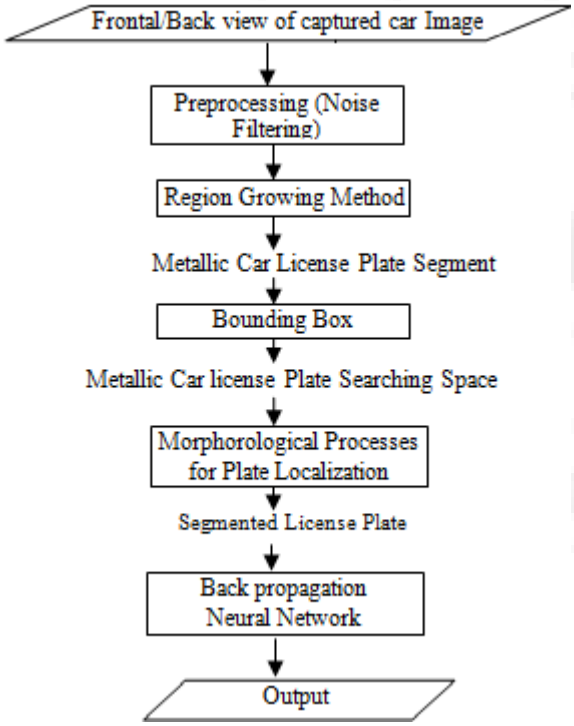


Figure 1: Overview of the Car License Plate Checking System

The initial phase of car license plate recognition system is to obtain images of vehicles. Electronic devices such as optical (digital/video) camera, webcam etc can be used to capture the acquired images. The images will be stored as color JPEG format on the camera. In RGB format, each Pixel has three colour components: Red, Green, and Blue. The colour image is given as an input and it is converted into gray scale image. The image is to digitize a "black and white" image composed of an array of grey shades is to divide the image into a number of pixels, depending on the required spatial resolution. This process is shown in Figures.

Figure 3(a): Original image

Figure 3(b): Resize image

Figure 3(c): Gray scale image

3.1 Preprocessing

In the preprocessing stage, the proposed system is take consider noise elimination. The median filter is widely used and very effective the removing of noise to discard salt and pepper noise and Gaussian noise. The gray scale image is removed the consisting noise of the captured image using the effective median filter. This process is shown in Figure 3.1(a).

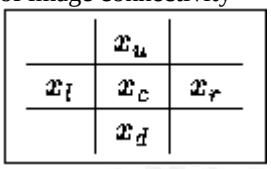
Figure 3.1 (a): Denoising Image

3.2 Region Growing Method

The first step for the car license plate segmentation is the reduction of searching space using a binary image resulting from Metallic part segmentation. The license plate is normally located near the metallic part. After segmentation of Metallic part, the license plate localization continues to carry out two operations, Morphological image processing.

The metallic front/back part is segmented by **region growing**. The input car image is converted to gray-scale for a simpler segmentation. The pixel aggregation is performed, using a rectangle (10 × 100) as a set of seeds in a regular position.

Algorithm of Region Growing
The following is a recursive algorithm based on a **4-connected** model of image connectivity



where x_c denotes the current pixel, x_i , x_u, x_r and x_d denote the upper, left, lower (down) and right pixels respectively in a 4-connected image matrix. The object is to compare the current pixel to each of the adjacent pixels to see if it can be added to an existing region.

An initial pixel must be found. This may satisfy some predetermined criteria, e.g. start with the most red or brightest pixel, or may start from some predetermined location, e.g. the centre of the image. When the recursive function terminates, there will, in general, be a group of pixels conjoined to form a labelled region with property I. The process must be repeated for another start pixel with similar or different property value. For example, if the goal was colour segmentation it might be appropriate to form the red regions, then when no more red pixels can be found to form the green regions and so on.

Algorithm for recursive region growing (4-connected version)

Start from point (x,y) with property I.
Recursive_label(x, y);
Begin
f(x, y) := label;
x := x - 1; { recurse left }
If f(x, y) = I and pixel not labelled then recursive_label(x, y);
x := x + 2; { recurse right }
If f(x, y) = I and pixel not labelled then recursive_label(x, y);
x := x - 1; y := y - 1; { recurse up }
If f(x, y) = I and pixel not labelled then recursive_label(x, y);
y := y + 2; { recurse down }
If f(x, y) = I and pixel not labelled then recursive_label(x, y);
End;

After metallic part segmentation, it reduces the searching space of car license plate because the license plate is normally located near the metallic part. It can define the searching space of bounding box related to the metallic part. Considering the bounding box of this region and supposing p_1 as the pixel in left-top and p_2 as the pixel in right-bottom corner, a reference pixel p or (p_x, p_y) can be defined as to follow:

$$P_x = (P_{1x} + P_{2x}) \text{ div } 2 , \quad P_y = P_{2y}$$

Finally, there is a region around of the pixel p that can contain the license plate. In tests, a distance sufficiently great d is defined in relation to bounding box dimensions of the metallic part:

$$d = max\{ 1/2(P_{2y} - P_{1y}), 1/6(P_{2x} - P_{1x})\}.$$

3.3 Morphological operators

The fundamental morphological operations include Erosion and Dilation. Opening and Closing are also morphological operators. These operators are considering as basic operations in image processing algorithms. Other operations are edge enhancement, convolution for the brighten image, filling all the region of image and thinning to the isolated character. The operations images are as the following figure.

Figure 3.2 (a): binary gradient mask

Figure 3.2 (b): clear border image

Figure 3.2 (c): convolution image

Figure 3.2 (d): filling and elimination of horizontal lines

3.4 Character Segmentation

Character segmentation is an important stage in many license plate recognition systems. There are many factors that cause the character segmentation task difficult, such as image noise, plate frame, rivet, and rotation and illumination variance [11]. Object segmentation is an essential task in computer vision and object recognitions. Image segmentation is the process of partitioning a digital image into multiple regions or sets of pixels.

Figure 3.3 (a): Segmented character

3.5 Character Recognition

Character recognition fully relies on isolated characters. Inefficiency of character segmentation influences the success of character to be recognized. In this recognition system, feed forward neural network and back propagation learning algorithm is used. The network consists of input layer, hidden layer and output layer interconnected by links that contains weights [10]. Character recognition final step in vehicle license plate detection and recognition is reading of single characters and numbers.

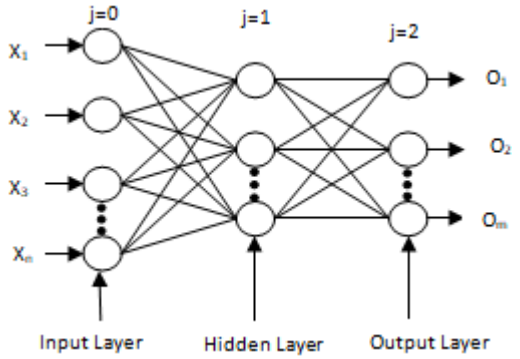


Figure 3.4: Neural Network architecture

3.5.1 Back propagation Algorithm

First the inputs are applied to the network and worked out the output. The initial weights are random numbers. The p th sample input vector of pattern $X_p = (X_{p1}, X_{p2}, \ldots\ldots, X_{pN0})$ and corresponding output target $T_p = (T_{p1}, T_{p2}, \ldots\ldots, T_{pNM})$ is presented. The input values to the first layer are passed.

$$Y_{oi} = X_{pi}$$

For every neuron i from input to output layer, the output from the neuron is found:

$$Y_{ji} = f\left(\sum_{k=1}^{N_{j-1}} Y_{(j-1)k}\, W_{jik}\right)$$

Here f(x) is sigmoid activation function.

$$f(x) = \frac{1}{1+\exp(-x)}$$

For the output layer, the error value is:

$$\delta_{Mi} = Y_{Mi}\,(1 - Y_{Mi})(T_{pi} - Y_{Mi})$$

And for hidden layers:

$$\delta_{ji} = Y_{ji}(1 - Y_{ji}) \sum_{k=1}^{N_{j+1}} \delta_{(j+1)k} W_{(j+1)ki}$$

Weight change is:

$$\Delta W_{jik} = \beta \delta_{ji} Y_{(j-1)k}$$

β is a constant learning rate.

3.5.2 Training of Network

In the training of BP neural network, input and output vector sets are prepared for 36 character sets as mentioned in image segmentation section. The designed ANN includes 209 nodes in the input layer, and 36 nodes in the output layer. The number of nodes in hidden layer is 36, and chosen experimentally. Learning rate and the momentum rate are experimentally chosen as 0.2 and 0.8, respectively. To train the network we begin to apply the first letter and change all the weights in the network. Next apply the second letter and do the same, then the third and so on. Once all 26 letters and 10 digits are done, we return to the first one again and repeat

the process until the error becomes small. We stop training once the network can recognise all the letters successfully, so the error fall to a lower value first. This ensures that the letters are all being well recognized. We evaluate the total error of the network by adding up all the errors for each individual neuron.

4. Experimental Results

Figure (3.5) is the performance of the recognition rate of the back propagation neural network recognizer. The highest recognition rate is 92% for Alphabets characters and 96% for Digit characters.

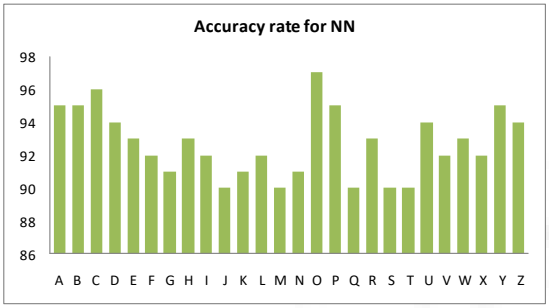


Figure 3.5(a): Accuracy rate for Upper Case Character

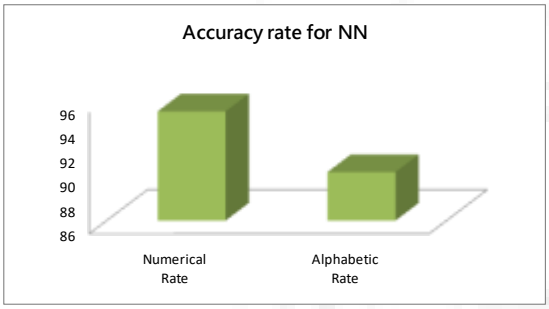


Figure 3.5(b): Accuracy rate for overall system

5. Conclusion

The proposed system implemented for the automatic car license plate using region growing, morphological operations and Neural Network used for character recognition. The automatic vehicle number plate identification system plays an important role in detecting security threat. The proposed system was implemented in Matlab software and its performance was tested on real images. A number plate recognition system is one kind of an Intelligent Transport System. Better speed and accuracy are achieved upon the whole architecture of the proposed system.

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