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The Improved Neural Network Algorithm of License Plate Recognition

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Abstract

With high definition cameras are widely used in urban traffic monitoring, the resolution of vehicle and traffic monitoring image rises. As the main component of intelligent traffic system, the vehicle license plate recognition technique faces new challenges and some new demands are put forward. Aiming at the problems of cutting down the time delay and eliminating characters outside of vehicle license plate, a set of license plate recognition algorithm is developed in this paper. The process of recognition in this paper is divided into four parts: image preprocessing, license plate location, license plate segmentation and character recognition. In license plate location, an accelerating matching method based on particle image correlation method is employed. In character recognition, an improved BP neural network algorithm is employed. The principle, procedure and simulation of the algorithm is described in details. High definition images with 2 mega pixels are used as the input of simulation.

Keywords: *Image processing, license plate recognition, high definition image, BP neural network*

1. Introduction

At present, a lot of license plate recognition algorithms have strict requirements for images that will be recognized, such as the size of the license plate. But with the SD (Standard Definition) surveillance cameras upgrading to HD (High Definition), the resolutions of monitoring images are improved. So some requirements of license plate recognition system can not be met anymore, such as time delay. The amount of computation increasing resulting from the amount of image data increasing makes the time delay increasing. At the same time, the expansion of the picture coverage leading by the usage of new type of cameras may causes the new problems, such as some other characters outside of license plate which need to be ignored are captured in the image. These characters make the license plate location algorithm complicated [1, 2]. These factors affect the license plate location and license plate character segmentation, and may cause the higher mistake rate and miss rate in vehicle license plate recognition [3].

Aiming at problems mentioned above, a set of license plate recognition algorithm is developed in this paper. The process of recognition in this paper is divided into four parts: image preprocessing, license plate location, license plate segmentation and character recognition. In license plate location, an accelerating matching method based on particle image correlation method is employed. In character recognition, an improved BP neural network algorithm is employed.

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2. Image Preprocessing

The resolution of widely used traffic monitoring HD camera in urban is 2 mega pixels, so in this paper the original images are all with 2 mega pixels. The image preprocessing in this paper includes converting original color image to gray image, and then median filtering the gray image. The input image is shown in Figure 1 and the results of image preprocessing, the gray image and histogram after median filtering are shown in Figure 2.

Figure 1. Input Image

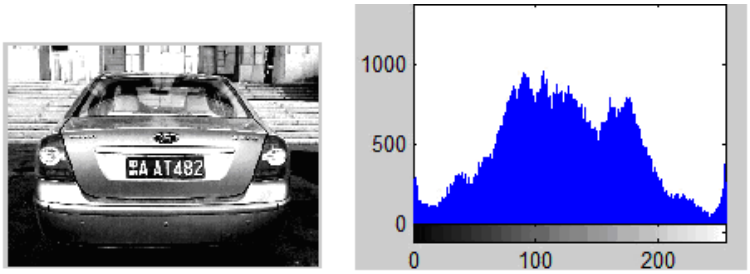

Figure 2. Gray Image and Histogram After Median Filtering

3. License Plate Location

License plate locating is one of the difficulties of the license plate recognition, its main function is to locate license plate in the image, and to extract the plate area out of the background of the image. In many situations, there is more than one license plate in the image and each of them should be extracted out. Because of large percentage of the computation amount is in license plate location, the main time delay of the whole process is produced in this procedure.

The increasing image data due to the using of HD camera influences the amount of data processing in plate location procedure largely and then affects the whole calculating time delay of the plate recognition algorithm. In order to improve the location speed, an accelerating matching method based on particle image correlation method is employed and introduced as follows [4].

The first step: fuzzy matching

(1) Only use the intercept and interlaced data of the image, so only one fourth of the license plate image data are processed. Due to the reduction of the amount of data, the speed of location improved.

(2) Determining the error threshold $E0$ as follows,

$E0 = e * \frac{l+1}{2} * \frac{c+1}{2} e$ is the average maximum error of each point; *l*, *c* are the length and width of the template respectively. When the real error is greater than *E*0, stop calculating on this point and continue to calculate the next point.

The second step: exact matching

Searching in the rectangular area of (i_{min-1}, j_{min-1}), (i_{max+1}, j_{max+1}) to get the final results, shown in Figure3.

Figure 3. License Plate Location Result

An example image with some other characters outside of license plate which need to be ignored is shown in Figure 4. After plate location by the method mentioned above, a leaning plate image is separated from the background, as shown in Figure 5.

Figure 4. Image with Some Other Characters

Figure 5. Extracted Leaning Plate

In order to solve the leaning problem of the plate image, Radon transform is employed to correct the leaning plate [5]. The final result after correcting is shown in Figure 6.

Figure 6. Plate Image after Correcting

4. License Plat Character Segmentation

Character segmentation refers to segmenting the rectangular image area with plate characters into small areas each has an individual character on it. Segmentation is the preprocessing for character recognition. Four steps of character segmentation are introduces as follows:

The first step: binarization processing of the license plate image.

The second step: median filtering the license plate image to remove noise.

The third step: erode the license plate image.

The fourth step: character segmentation. In this paper, the vertical projection method is employed for the character segmentation. There are three procedures of vertical projection method [6].

(1) In the license plate image, the width of each character is certain, and the space between the second and the third characters is larger than space between other characters. Therefore, after performing the vertical projection, the width of each character is defined as the length of segmentation, and the left and right endpoints of the plate image is used as the boundary.

(2) In projection calculating, due to the possible presence of the license plate frame, there will be a large peak, then between the left and right boundaries will appear valleys. Therefore, the projection should be taken based on the exact height and width within the license plate boundaries, and the height and width of each character. And then use the vertical projection of character segmentation method.

(3) Calculating the width of the first character and the last character, comparing them to the average width of the seven characters to avoid merger mistake.

The result of character segmentation of Figure 3 is shown in Figure 7.

Figure 7. Diagram of the Host and Coordinator

5. Character Recognition by Improved BP Neural Network

Character recognition is the core in the license plate recognition and is also focused. Today there are many kinds of character recognition algorithms, the most widely used is the recognition method of BP (Back Propagation) neural network.

BP neural network is a multilayer feed forward network obtained by back propagation error algorithm. BP network can learn and store large amounts of input-output mode mappings without prior reveal mathematical equations that describe this map. BP neural network topology includes an input layer, a hidden layer and an output layer [7].

BP neural network has the advantage of nonlinear mapping capability. BP neural network is essentially implements a mapping from input to output, the mathematical theory of three-layer neural network proved to arbitrary precision can approach any nonlinear continuous functions [8]. But it is well known that BP neural network algorithm converges slowly. Due to the nature of the BP neural network algorithms is the gradient descent method, it is inefficient to optimize the complex objective function. Also, in the neuron output close to 0 or 1 case, some flat areas appear. In these regions, the value of weight error adjusts very small every time, so that the training process is almost standstill [9]. BP network has another problem of forecasting ability and training capabilities contradictions. Predictive capability also called generalization ability, and training capacity, also known as learning ability. In general, poor training ability, the prediction ability is poor, and to a certain extent, with the ability to improve the training, prediction ability will be improved. However, this trend is not fixed, there is a limit. When this limit is reached, with the improvement of training capacity, the prediction ability will decrease, *i.e.*, so-called "overfitting" phenomenon.

In this paper, the BP neural network is improved in two ways as follows.

(1) Batching the learning samples

In the standard BP learning progress, one sample is used for one cycle of correcting the coefficients. That is the correcting reflects the local characteristics of

the sample space. In order to reflect the samples space all, every cycle uses all training samples. This produced a batch learning method [10]. The batch learning is to be able to get all the samples are submitted to the BP network, according to the output of the average value of the error to adjust the network. In this way, the learning time is reduced, and the phenomenon of excessive cumulative will be avoided, so that the BP network learning speed can be improved.

In Figure8, we see the training error of the batch method to decrease much faster than the standard BP, and the training speed is greatly improved.

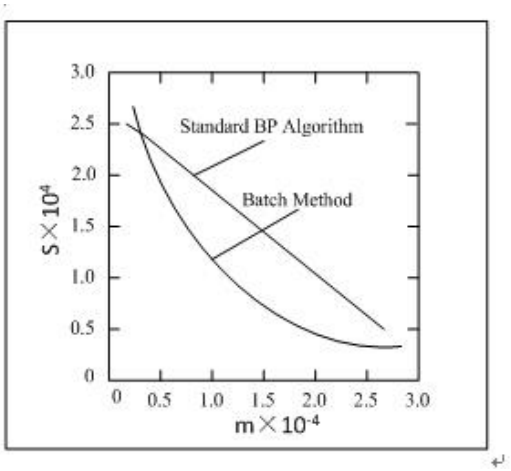

Figure 8. Training Error Contrast

(2) Using the inertia impulse to reduce vibration

In this paper, adding the inertia impulse method by Rumelbart is employed in adjusting the coefficients. This method can filter out high frequency oscillation in the learning process. Tab.1 is the results contrast between the standard BP network and the improved BP network [11].

Table 1. Results Contrast between Standard BP and Improved BP

Algorithm	Result
The input vector	P={-1 -2 3 1；-1 1 5 -3}
The objective function	t={-1 -1 1 1}
The hidden layer	3
The number of nodes	1
Transfer function	$F(x)=1/(1+e^{-x})$
Error	0.001
Learning factor	0.05
The number of iterations	1000
Impulse coefficient	0.9
The standard BP algorithm learning speed	1400s
Improved BP algorithm learning speed	600s

6. Conclusion

Recognition character with improved BP neural network, the batch method and the adding inertia of impulse method can improve the learning's speed, and increase the number of samples, and increases the recognition rate. So the improvement of BP neural network algorithm in this paper is effective. The improved method meets the requirement of speed in dealing with the traffic images sampled by HD camera with 2 mega pixels.

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