Survey on The Methods Used in The Recognition Part of The License Plate

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الخلاصة

يستخدم تميز لوحات ارقام السيارات في العديد من الانظمة الحساسة والمهمة مثل تتبع السيارات المسروقة، إدارة مواقف السيارات، ومراقبة حركة المرور. تتكون عملية تميز لوحات ارقام السيارات من ثلاثة مراحل؛ المرحلة الأولى هي تحديد موقع اللوحة، والمرحلة الثانية هي تجزئة اللوحة الى صور مفردة للحروف والارقام والمرحلة الثالثة هي تميز تلك الحروف والارقام. لوحة رقم السيارة تتأثر بالضوضاء في العالم الحقيقي نتيجة الإضاءة وزاوية الكاميرا، وبذلك تتأثر دقة التحديد والتجزئة. هناك العديد من الطرائق لكل مرحلة، واختيار أي طريقة منها يعتمد على نوع التطبيق وبيئته وكذلك وقت التنفيذ. في هذا البحث، سوف نستعرض وندرس الأساليب المستخدمة في مرحلة تميز الحروف والارقام.

الكلمات المفتاحية

تمييز لوحات ارقام السيارات، نمط المطابقة، التعرف الضوئي على الحروف.

Abstract

License plate recognition has been entered in many critical systems like tracking stolen cars, traffic surveillance and parking management. License plate recognition process consists of three parts; the first part is identifying the position of the license plate, second, segments license plate into individual image characters and the third is recognizing these characters. License plate is influenced by the noise in the real world such as illumination and angle of the camera, so that the accuracy of locating, segmenting and recognizing are affected. There are many methods for each part, choosing any method of them depends on the type of application and its environment as well as the execution time. In this paper, we will survey and study the methods used in recognition part.

Keywords

License Plate Recognition, Pattern Matching, Optical Character Recognition.

1. Introduction

License Plate Recognition (LPR) systems are found in many applications which need to identify the plate of cars. These applications have become one of the necessities of the modern era especially in big cities. Examples of these applications are traffic surveillance [1], tracking stolen cars [2]. Also LPR uses in Speed Sign [3] and parking management [4]. LPR systems consist of three parts, Fig.(1) [1]. The first is detection part, which detects the license plate; identify the rectangle which is license plate from captured image. The second part is segmentation, which segments the plate in isolated image that represents individual character. The third part is recognition part, for recognizing the characters.

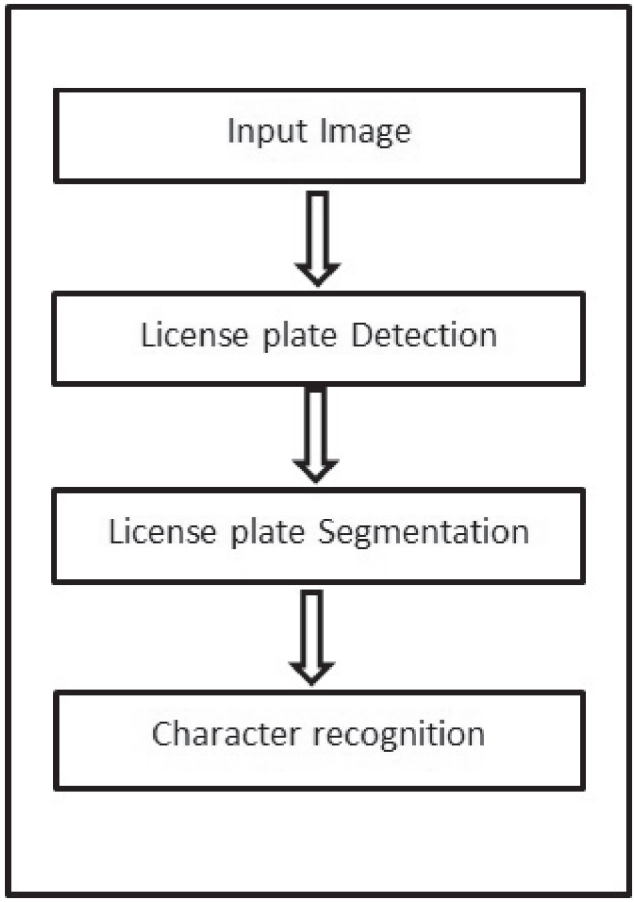

Fig. (1): Three parts of license plate recognition

For these three parts, there are many methods used to complete it. In detection part, [5] use the canny edge detection, in [4] combines Canny detector and Hough transformation. While in [6] employ 2D Haar Discrete Wavelet Transform (HDWT). in [7] in addition to wavelet transformation utilize the projection method, and in [8] edge detection with morphological dilation operation and region growing segmentation are used to detect the license plate. In segmentation part, in [7] projection method is used. Row and Column Sum approach was suggested in [1]. Other use Morphological Erosion Operation and Region Growing Segmentation [8]. Applying the dilation operator for isolating the two closer characters and then apply the partition scanning

to segment the characters in [9].

In characters recognition part, Ching et al. [7] use back-propagation neural network while in [8,10,11] use perceptron neural network. In [1], Waqas Ahmad et al. use statistical approach which is suitable implementation on (fixed point Digital Signal Processor). In [2] and [12], four sub-classifier and Structural Methods are applied. Lastly, in [4] and[13] use template matching, in [14] initially, they extract features then apply template matching.

It is clear that captured image from real world is accompanied by noise and the image may be rounded or have picked up at an angle of rotation. The distance between the camera and car also has influence. Thus, preprocessing to these images must be done. These preprocessing may be in any step of the license plate recognition.

This paper will focus on the recognition part, list some methods which are proposed in recognition step and refer to their preprocessing and evaluate it by the accuracy and the execution time.

2. Optical Character Recognition

This distinguishes character electronically from images known as optical character recognition (OCR), (recognize the typewritten characters and handwritten characters). In addition, OCR uses in signature recognition [15]. The methods which fall in design of OCR are neural network, template matching, structural systems and feature systems [16]. Selecting any one of these methods depend on the purpose of OCR, the available time and the image features. OCR is the third part in the process of recognition of the license plate.

3. Methods of License Plate Recognition

There are many techniques used in License Plate Recognition part (LPR), and development in image processing, artificial intelligence and data mining led to progress in LPR will list the methods that are used in LPR in three categories neural network, classifiers and statistical approach and template matching. The neural network is also one of the classifier categories but isolated to their importance and frequent use.

3. 1. Artificial Neural Network

Artificial Neural Network (ANN) is useful in clustering, pattern recognition, classification, prediction and others. In general ANN consists of input layer, one or more hidden layer and output layer see Fig.(2). There are two major types of ANN.

The first is feed-forward and the second is backward, in case of forward pass data from input layer through hidden to the output layer unlike backward network also called (back-propagation network) the weight is update by passing the error to back (from output to hidden and then to the input layer) in the input layer update the

weight and start again to the output layer.

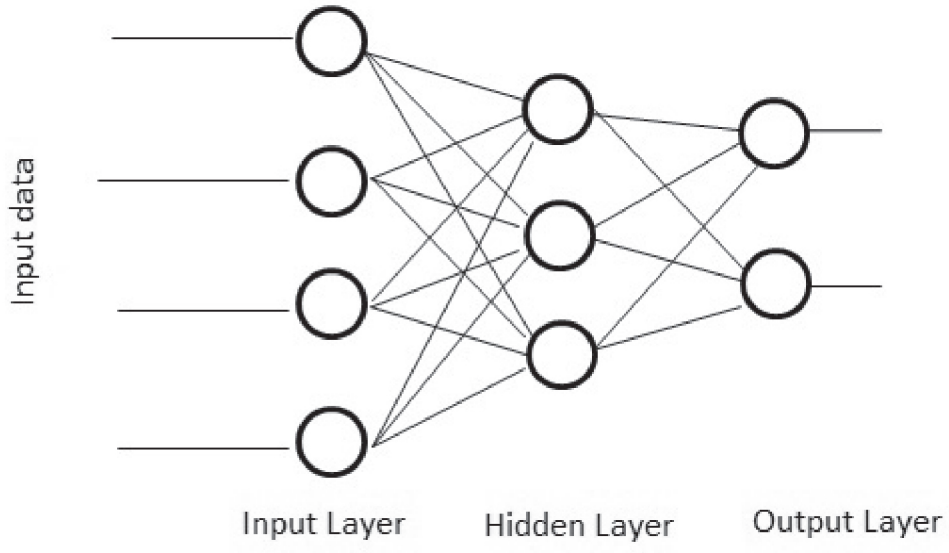

Fig.(2): The layers of Artifical Neural Network ANN

3.1. 1. Back-Propagation Neural Network

Ching et al. in [7] use back-propagation neural network for recognition. They apply the Black top-hat technology to remove the shadow. In the experimental execution they measured accuracy according to the speed and the results were (20 - 60 speed : 91% - 82% accuracy).

Yifan Zhu et al. in [17] normalize the segmented images into a 25×50 (pixels). For extract features they use a grid feature which is frequently used in OCR. They apply back-propagation neural network to classify and use statistical analysis to obtain the best results. The accuracy was 93.5%. Zhigang and Cong in [18] use four networks and they achieve 91.2% accuracy for Chinese character network, 94% accuracy for litter and digit network, 93.5% for English character network and 96.1% for digital network.

3.1. 2. Feed-Forward Networks

R. T. Lee et al. in [6] apply 2-D Haar Discrete Wavelet Transform (2-DHDWT) to reduce the pixels of image three times. 2-DHDWT decompose the image into four bands according to the frequency (high, low and combine of them, HH-HL-LH-LL). Select the LL and use ANN for recognition, they achieve 95.33% accuracy. Dhawal Wazalwar et al. in [8] use perceptron neural network and for activation function use a log sigmoid. The accuracy was 97.05% with clear image.

VinhDu Mai et al. in [10] use two multilayer perceptron (MLP) neural network one for recognition the characters and another for numbers recognition. But in training use back-propagation neural network is used, and they chose sigmoid function as activation function. In experimental execution they achieve results with 97.25% accuracy in 0.25 (s). Kaushik Deb et al. in [19] use ANN with two layers just input and output layers. At first they convert the segmented images into binary images and normalize it

into 12×12 pixels, thus the input layer was 144 neurons. They obtain 99% accuracy in 0.22 (s) execution time for detecting boundary and normalization of character and 0.06 (s) for recognition the character.

Saeed Rastegar et al. in [20] apply dilation operation and normalize the segmented image in 20×30 (pixels), then use MLP network. The accuracy of recognition was 99.2% in 0.14 (s).

A. Akoum et al. in [21] use two of ANN, Hopfield Network (HNN) in which the output is connected to the input and the second is MLP, with HNN achieved 87% accuracy and with MLP 80% accuracy but the HNN consumes time more than MLP.

Othman Khalifa et al. in [22] and V. Koval et al. in [23] use MLP network and in training they use (BP), in [22] achieve 93.2% accuracy and in [23] achieve 95%. Ankush and Debarshi in [24] use MLP with total system accuracy 91.59%.

Bo Li et al. in [25] apply radial basis function artificial neural network which consists of input layer, output layer and just one hidden layer. The accuracy was measured in day and at night, 91% in day and 81% at night, the total time was 1.3s.

3. 2. Classifiers and Statistical Approach

Waqas Ahmad et al. in [1] use (fixed point Digital Signal Processor) because it convenient to perform the statistical operation. To recognize the digit they use Statistical approach which depends on extracting the features, connecting compounds and ending the point. The digit has either one, two or three the compound (connected compound). The number and position of the end point also were used in recognize the character. They achieve 91.66% accuracy in 0.01 (s).

Pan Xiang et al. in [2] apply statistical methods, and to do that they used four sub-classifiers for recognizing the segmented images. They used Structural Methods to distinguish characters which have converge in the shape of them. These sub-classifiers were performed by template matching, but they differ in how to extract features. The first classifier uses (zoning density), the second classifier uses (vertical projection), the third classifier use (left- right contour feature) and the fourth classifier use (line segment features). After that they use the Bayes method [26] to combine the result of four subclassifiers. The characters like 8,B,0,D which have similar in shape can distinguish them by applying (Structural Methods) to extract the structure features and input these features in decision tree. They achieve 95.41% accuracy. R. F. Mansour in [12] first performs four sub-classifiers then uses (Bayes method) to combine the result from four sub-classifiers.

Fajar and Roenadi in [27] use Hidden Markov Models (HMM) with 26 class (A-Z) and 10 class to numbers (0-9). In order to obtain features they count the number of foregrounded pixels. They perform training to get the HMM parameters and then use it in testing. They achieved 93,20% accuracy in 1.140 (s) execution time for recognition step.

Mohammad and Rahele use Multi-class AdaBoost. AdaBoost is merged several poor classifiers to produce powerful classifier[28]. They achieved 94.5% accuracy for character recognition [29].

Zhu et al. in [30] use decision tree classifier based on bagging and they achieve 93.5% accuracy in day and 90.1% at night.

Support vector machines SVM is powerful in classification and use in data mining and pattern recognition, to isolate the data in classes the SVM use hyperplanes, the optimal one is selected [31].

Lihong Z. and H. Xiangjian in [32] use multiclass model of SVMs. There are two types of multiclass SVM, one against all and one against one. They chose one against all to perform the process of recognition. They design two sets of SVMs one for letters and another for digits, the accuracy of digits recognition is 98% in 0.6s testing time and the accuracy of letters recognition 98.8% in 0.31 (s) testing time. Lekhana and Srikantaswamy in [33] use support vector machine. Babak and Eslam in [34] use SVM (one-against-all) and they obtain 99.50% accuracy in 0.021 (s).

Reza Azad et al in [35] extract two kinds of features, distance feature and angle feature, to use it with (k-nearest neighbor KNN) classifier. They divided the data set of character into three strategies. the first strategy consists of 70% from the data set in training phase and 30% in the testing phase, the second is 80% in training phase and 20% in the testing phase and the third has 100% in training phase and 100% in testing phase. The results are 99% for the first strategy, 99.12% to the second and 100% to the third strategy with (K=2) for all.

3. 3. Recognition with Template Matching

In general the template matching required database for storing the information of characters images and then doing matching the new information with it.

Saqib Rasheed et al. in [4] found database to store the templates (A-Z, 0-9) which are used to match with the segmented image, they use (cross-correlation method) to do matching. The accuracy of Recognition was 90.62% in 0.6 (s). S.H. Mohades Kasaei et al in [9] normalize each character to a 38×20, and then match with database.

Choudhury A. Rahman et al. in [13] use library to store histogram of characters (A-Z, 0-9), 15 horizontal and vertical histogram and compare the segmented character with this library to recognize it. Yao Yuan and Wu xiao-li in [14] first extract feature then apply the template matching. M.A. Massoud et al. in [36] use template matching, the accuracy 91%.

Hamidreza and Mohammadreza in [37] perform normalization then apply the matching with database and select the best similarity they use a statistical method correlation based, the accuracy of recognition is 92%.

M J. Ahmed et al. [38] at first normalized the segmented character then match they with the data base which prepared and normalized before.

Some methods, their accuracy and execution time are tabulated in Table (1).

Table (1): Summary for the LPR techniques

ANN: Artificial neural network , BPNN: back-propagation neural network, RBFANN: radial basis function artificial neural network, HMM: Hidden Markov Models, SVMs: Support vector machines, TM: template matching, NR: not reported, T.T.: total time, R.T.: recognition time, T.AC.: total accuracy.

Ref.	R. Algorithm	Accuracy	Time
[6]	2-D Haar Discrete Wavelet & ANN	95.33%	NR
[7]	ANN	88.71%	NR
[8]	ANN	97.05%	NR
[10]	ANN	97.25%	T.T. 0.25 (s).
[17]	BPNN & Statistical Analysis	93.5%	NR
[18]	BPNN	94%	NR
[19]	ANN	99%	R.T. 0.28
[20]	ANN		R.T. 0.14 (s)
[21]	ANN, Hopfield Network	87%	NR
[22]	ANN	93.2%	NR
[23]	ANN	95%	NR
[24]	ANN	91.59% T.AC.	NR
[25]	RBFANN	91%	T.T. 1.3 (s)
[27]	HMM	93,20%	R.T 1.140
[29]	Multi-class AdaBoost	94.5	NR
[32]	SVMs	98% to digits & 98.8% to letters	0.6s testing to digit & 0.31s to letter
[34]	SVMs	99.50%	0.021 (s)
[35]	KNN	99% 70% of data to training & 30% to testing	NR
[4]	TM	90.62%	0.6 (s)
[36]	TM	91%	NR
[37]	TM	92%	NR

4. CONCLUSION

There are many uses for LPR, thus. Numerous research and studies are suggested to find the best algorithm for recognizing the LP. Some of the literature focused on accuracy and other focus on execution time. We note from search in literatures that the ANN was frequently used in recognition the LP and it take less time while the template matching takes more time. Data mining techniques help in improving the process

of recognition. The methods which use to extract character's features will affect on the accuracy, so, extraction features, number of pixels and the technique which will use are very important in reducing the execution time and increasing the accuracy. Thus, this must be careful when applying any one of techniques b y taking the most important features and the enough number of pixels to achieve optimal results.

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