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An Improved Method to Recognize the Iraqi License Plates Using Local Projections

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Abstract

The License Plate (LP), is a rectangular metal plate that contains numbers and letters. This plate is fixed onto the vehicle's body. It is used as a mean to identify the vehicle. The License Plate Recognition (LPR) system is a mean where a vehicle can be identified automatically using a computer system. The LPR has many applications, such as security applications for car tracking, or enforcing control on vehicles entering restricted areas (such as airports or governmental buildings). This paper is concerned with introducing a new method to recognize the Iraqi LPs using local vertical and horizontal projections, then testing its performance. The attained success rate reached 99.16%, with average recognition time around 0.012 second for recognizing a single alphanumeric symbol .

Keywords:License plate,Recognition, Local Projection, Alphanumeric Recognition.

طريقة محسّنة لتمييز لوحات تسجيل السيارات العراقية بأستخدام الأسقاطات المحلية

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الخلاصة

ان لوحة تسجيل السيارة (LP) عبارة عن صفيحة معدنية تحوي أرقام وحروف، ويتم تثبت اللوحة على جسم العربة. وهي تستخدم كوسيلة للتعرف على العربة. ان نظام تمييز لوحات التسجيل LPR هو الوسيلة التي يمكن من خلالها التعرف على العربة بشكل آلي بأستخدام نظام الحاسوب. ان نظام تمييز اللوحات (LPR) له تطبيقات عدة، مثل التطبيقات الأمنية المتعلقة بتتبع السيارات، أو فرض السيطرة على دخول العربات لمنطقة محددة (كالمطارات أو المباني الحكومية). تعنى هذه المقالة البحثية باقتراح طريقة جديدة لتمييز لوحات تسجيل السيارات العراقية بأستخدام الأسقاطات المحلية العمودية والأفقية، ومن ثم اختبار اداؤها. ان نسبة التمييز التي تم التوصل اليها وصلت إلى 99.16% وبمعدل وقت للتميز حالي 0.012 ثانية لتمييز اي شكل لحرف أو رقم.

1. Introduction

Since the number of vehicles is increasing largely every year, then the process of controlling and tracking those vehicle forms a significant human challenge. The automatic recognition of those

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vehicles can help in solving this problem, and save much effort and time. The License Plate Recognition (LPR) system is a form of automatic vehicle identification.

The applications of the LPR are varied, they may include: stolen cars tracking, parking control, enforcing the entry for authorized people to certain areas, and speed control.

The first LPR system was appeared in United Kingdom in 1976. Since that moment; many countries applied automatic LPR systems[i], officially, but Iraq was not among them. This stimulated researchers attention to develop new methods to recognize the Iraqi License plates (LP) using Local vertical and horizontal projections.

2. Related Works

Many researches tackled the problem of recognizing the extracted alphanumerics objects from LPs for different countries. These researches explored different methods, algorithms and techniques. Scope of the recently used methods and techniques are reviewed below. The facts that are mentioned about the surveyed literatures depend on what is documented in them.

Template matching is a popular method that is used in many researches. Devapriy and et al. [1] used Template matching to find the similarities between a predefined template and input image. The cross correlation template matching technique is used to recognize the LP characters. Two common matching functions are used to find an exact or a close match. A collection consists of 500 car images of Indian LPs were tested in their research, they referred that the best attained success rate was (98%). The template matching was used by Sharma and et al. [2] to compute the correlation between the template and a segmented block of character. The maximum size of the used images reached to 603x399 pixels. There was no clear Figures in their research paper clarify the number of images used in testing phase and about the best attained recognition rate. In this literature, also, there is no documentation about the core features used to recognize the LP characters, and the distance measure is not presented too.

Also, template matching was applied by Basalamah [3] for comparing the segmented Saudi License plates with the reference templates using simple certain comparison equation, in which all of segmented images are compared to a reference template. The character images are normalized to the size of 50x50 pixels. The total number of the used images was 140 LP image. The success rate reached to 81%.

Cheng and Bai [4] used a cascade consists of two steps template matching which are based on the Connected Domain Feature (CDF) and the Standard Deviation Feature (SDF), respectively. The images are normalized to the size of 32x16 pixels. A set of 322 Chinese character images were used. The number of correctly passed images was 309 (which corresponds to success rate 95.99%).

Neural networks methodology is commonly used in many researches to recognize the LP characters and numerals. Laxmi and Rohil [5] have used the features of the segmented LP characters which are extracted using Haar Wavelet, and then recognize them using back propagation neural network. Different numbers of car images were used to test the system. The best achieved success rate was around 88% when 30 image are exploited for the training issues, while the elapsed time was 42 seconds.

To recognize the LP of Nigerian vehicles, the neural network was used by Amusan and et al [6]. The weights of the neural network were adjusted by training it using back propagation algorithm. Different categories of plates were used to test this system. The highest success rate that is registered in this work reached 96.25% when 320 character images were tested, and the processing time was 3.62 second.

The recognition of LPs was experimented by Ganapathy and Lui [7]; was done through the implementation of feed-forward backpropagation artificial neural network. The images of segmented LP characters were normalized to fix size of 25x15 pixels. A set of 589 Malaysian car images were used to test the system, 95% of these images have pass the recognition test.

Perwej and et al. [8] have applied the Learning Vector Quantization artificial neural network to implement the recognition of LPs. The images were normalized to the size of 150x100. The total number of used car image was 350 images. The success rate reached 94.91%.

To identify the vehicles in Kurdistan Region of Iraq, an approach was used by Ali and et al. [9]; it was based on using the concept of Gabor feature vector and different classifiers (i.e., support vector machines, K-nearest neighbors and Radial basis function) in order to classify the LP features. A set consists of 1000 car images used as test material. The size of each image was normalized to the size 309x240 pixels. The attained recognition success was 96.72%.

Also, the K-Nearest neighbor method was used by Azad and et al. [10] to recognize the Iranian LPs. In this work, a set of 800 character images were extracted from the LPs. The number of correctly recognized images was (792), which corresponds to success rate (99.12%).

The optical character recognition that uses the correlation method to match each individual LP alphanumeric was applied by Sutar and Shah [11]. The images were normalized to the size of 1536x2048 or 640x480. The total tested LP image was 90. Eighty four images were correctly passed the test; which corresponds to recognition rate (93%). The whole processing time was 45 seconds.

Sarker and Song [12] have used a set of features based on Local Line Binary Pattern (LLBP). This method includes obtaining a binary code with respect to the horizontal and vertical direction individually as the first step. While the second step is computing the magnitude, which typifies the variation in image intensity such as edges and corners. Hamming Distance was used as a similarity measure. A set consist of 1000 of Korean LP images were tested. The recognition rate reached to 97.74%.

Ashtari and et al. [13] have studied the use of a hybrid classifier that comprises a decision tree and support vector machine to classify the features that are extracted from the LP images of Iranian LPs. As an example for the extracted features: the number of holes in the character, which is called Euler number, also the periodic vertical and horizontal searches to find changes in edge, in addition to dividing a character into a predefined number of tiles, such as 6x4 or 4x6 or 5x5 and then using the ratio of object pixels to background pixels of each tile is a proper feature for recognition. The attained recognition rate was (94.4%).

From the point view of networks, the connectivity of image pixels can be considered as complex network, based on the previous statement Ren and Ma [14] had conducted their research. In this paper the skeleton of characters is extracted from Chinese LPs using thinning algorithm; then it is mapped to a weighted complex network. The feature vector of the network was used as a template. The images are normalized to the size of 40x20 pixels. The attained recognition rate was 98.19% for 700 character samples. The average processing time was 33.63 milliseconds per character.

A comparison between the letters and numbers extracted from Iraqi LP (used in Kurdistan Provinces) with the corresponding templates registered in a pre-established database was done by Aziz [15]. No details were mentioned about the tests steps. A set consists of 57 car images was used as testing material, 54 images were recognized successfully.

Two approaches have been used by Kamal and George [16, 17] to recognize the Iraqi license plates. The first method is the moment based method, the second method is the local density distribution method. Different types of tests were experimented in this paper. A set consists of 1784 LP characters images were used as testing samples. The best success rates for the used methods was 92.49% and 98.99%, respectively.

3. System Layout

Generally, any LPR system using video frames or still images consists of basic phases, it may include: image acquisition, preprocessing, LP extraction, LP alphanumeric objects segmentation, and LP alphanumeric recognition. The general layout for the proposed system is presented in Figure- 1.

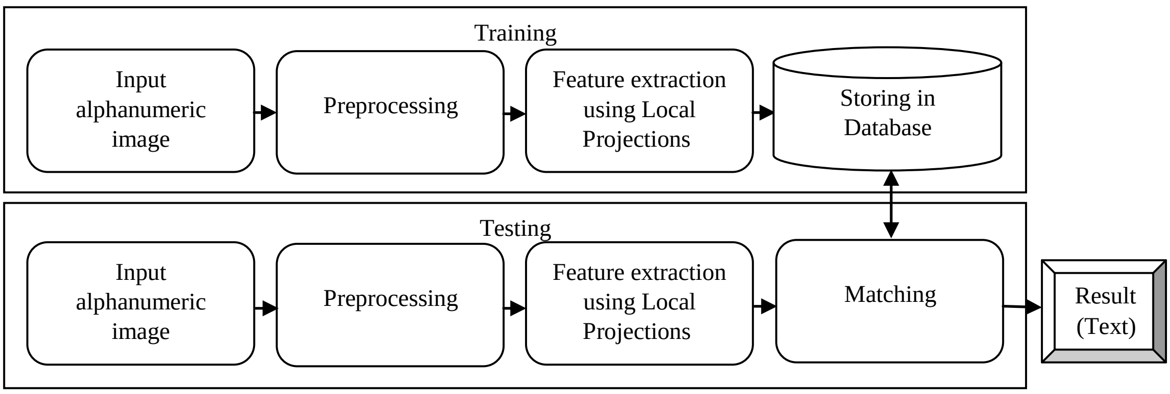


Figure 1- The diagram of the introduced vertical and horizontal projections based system for automatic LPR.

3.1 Preprocessing

The applied preprocessing stage involves three basic steps to prepare the image for recognition stage. These steps include: converting the image to gray one, convert this gray image to a binary one, and then normalizing the image dimensions. These steps are explained in details below.

A. Getting the Gray Image

Since the alphanumeric images come in 24 bit per pixel as a depth for each pixel in the image, the image bands of red, green and blue are extracted for each of the tested images. Then, the gray image is obtained using equation 1.

$$Gray\,(i,j)= (Red(i,j) + Green(i,j) + Blue(i,j))/3 \qquad \textbf{(1)}$$

Where the pixel at the location *(i,j)* in the Gray image is obtained as the average of red, green, and blue bands.

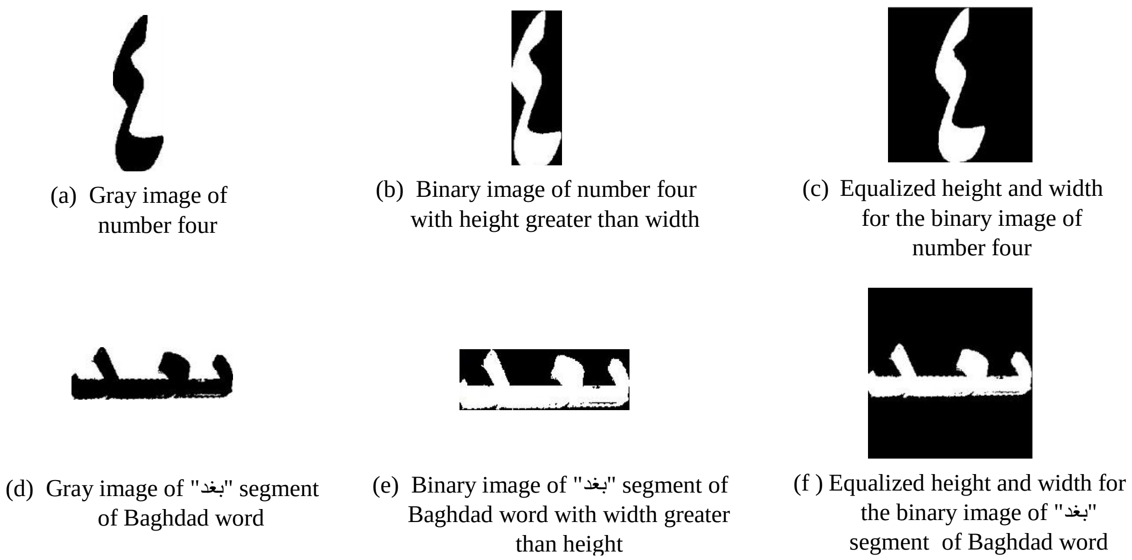
B. Getting the Binary Image

The goal of this stage is the conversion of alphanumeric gray image into a binary form. The region of interest of the alphanumeric shape will be turned to white, while the background will be mapped to a black color.

A threshold of 128 was used to convert the alphanumeric image to the required binary image. 128 represents the mid value of the range between 0 and 255. To get the binary image, the pixels of the gray image are scanned to specify if the pixel value met the condition of being less than the threshold value, then, it will be turned to 1, otherwise it will be set to 0.

C. Equalization of Image Dimensions

Image dimensions equalization implies making its height and width equal. Making image dimensions equal will lead to equal areas and, consequently equal number of blocks, for gaining local set of features each subset represents certain spatial behavior of the alphanumeric object. To get images with equalized dimensions, zero padding method was applied along the both sides of the shortest dimension of the binary image. The applied preprocessing steps are clarified in Figure- 2.



(a) Gray image of number four

(b) Binary image of number four with height greater than width

(c) Equalized height and width for the binary image of number four

(d) Gray image of "بغد" segment of Baghdad word

(e) Binary image of "بغد" segment of Baghdad word with width greater than height

(f) Equalized height and width for the binary image of "بغد" segment of Baghdad word

Figure 2-Preprocessing Steps.

3.2 Feature Extraction using Local Projections

This stage was used to get the image features, and then the extracted features are used to recognize the alphanumeric image. This step includes partitioning the binary image of the equalized dimension into overlapped blocks. Since the image block is equalized in its dimensions, then the image blocks will set to same size; this means that all the processed blocks will have same number of pixels. These blocks will be overlapped or interlaced to certain ratios. The overlapping leads to better recognition rates, because it is compensate for the local drifts, and deviations related to the shape of the alphanumeric for image samples in the same class.

The number of all blocks equals to the squared number of blocks along one of the two dimensions. That means if the image is partitioned into four blocks along certain dimension, this will lead to sixteen (4^2) blocks over all image segment.

For each block (or tile) of the image, the vertical and the horizontal projections are calculated. The value of these projections will be stored in two arrays, each of these arrays is a one dimensional array; i.e., V(Y) for the vertical projection and H(X) for the horizontal projection. These two arrays will represent the features of each segment.

The lines of the binary block will be scanned for each direction individually. The cell of the projection array of a direction will be set to 1 whenever *a white* pixel is encountered in the scanned line of the specified direction for the local part of the binary image of the alphanumeric. See Figure- 3.

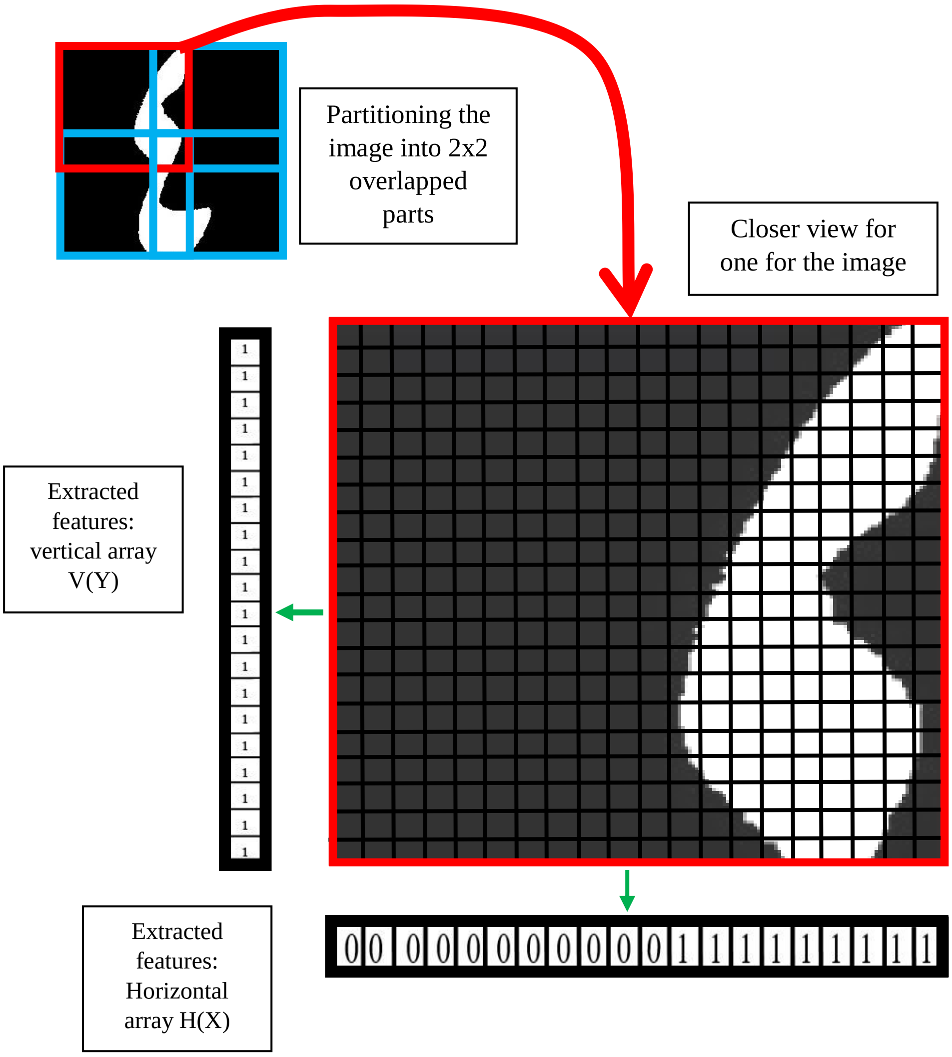


Figure 3- An illustration of feature extraction steps.

3.3 Template Creation and Matching Equations

The number of features (n_{feat}) that is extracted from a single image segment equals to what is shown in the following equation:

$$n_{feat} = 2 * N \ , \qquad (2)$$

Where, N refers to the number of tiles along each direction for each image segment.

The mean and standard deviation vectors for the extracted feature vectors from the training set of samples were determined and used as templates for representing each class of alphanumeric segment. Single mean and standard deviation vector is assigned for each template.

For each image class, 70% of the total images have been used to create the templates. Note, that there are 8 classes, each of which contains six or less than this number as image samples, so for these

cases all samples were included to determine the corresponding templates. The class numbers for these small classes are (10, 12, 16, 17, 23, 25, 26, and class 27), as shown in Table 1.
For matching task, four different equations have been used as similarity distance measures to determine the membership of the tested input alphanumeric image for certain class. The used distance measures are described in the equations:

$$D_1(i,j) = \sum_{k=1}^{N_{feat}} \left(\frac{f_i(k) - \mu_j(k)}{\sigma_j(k)} \right)^2 \quad (3)$$

$$D_2(i,j) = \sum_{k=1}^{N_{feat}} \left| \frac{f_i(k) - \mu_j(k)}{\sigma_j(k)} \right| \quad (4)$$

$$D_3(i,j) = \sum_{k=1}^{N_{feat}} \left(f_i(k) - \mu_j(k) \right)^2 \quad (5)$$

$$D_4(i,j) = \sum_{k=1}^{N_{feat}} \left| f_i(k) - \mu_j(k)^2 \right| \quad (6)$$

Where, D is the distance between the i^{th} input feature vector, $f_i()$, and the j^{th} template vector; k represents the feature index number. The range of values of i and j depends on the total number of classes (i.e., [0-27]). N_{feat} is the number extracted features from each segment sample. μ denotes for the mean, while σ refers to the standard deviation value.

4. The Database

The sample images used to test the proposed system have been extracted by the researchers using different photos for various versions of Iraqi license plates, which have different styles. There are many differences between the LP belong to different versions. The total number of samples was 1785 image sample. They are classified manually by the researchers into 28 classes. Each class holds different number of image samples. The alphanumeric classes with their corresponding numbers of samples are listed in Table- 1.

All these images are stored as Bitmap (BMP) files, with the color depth 24 bits per pixel. The size of these images ranges from 11x13 to 284x245 pixels. All images come in a form such that the foreground color of alphanumeric body is black, while the background color is set to white.

Table 1- The database of the 28 used classes with the number of image samples of each class.

A Sample from the Class	Class Index Number	Number of Samples per Class	A Sample from the Class	Class Index Number	Number of Samples per Class
٠	0	88	د	14	67
١	1	126	د	15	12
٢	2	198	د	16	4
٣	3	97	ىلما	17	2
٤	4	114	صى	18	14
٥	5	99	ڡتص	19	13
٦	6	175	ڡ	20	68
٧	7	130	ڡ	21	12
٨	8	75	لعـر	22	160
٩	9	109	لعر	23	3
لا	10	4	مو	24	13
دعـد	11	174	ىىا	25	4
ســل	12	6	ىا	26	3
حصو	13	13	لـى	27	2
Total Number of Samples = 1785					

5. Tests Results

Three strategies were used to test the proposed method. For all of these three tests, the four distance measures mentioned in the above section were tested individually. The percentage of the true positive samples is calculated, and the required time for single alphanumeric image is documented. In these strategies different number of tiles per image is tested (i.e., 2x2 to 20x20 tiles). The considered rate of overlapping was taken from 0 to 1.

For strategy (A) the 70% of the samples (which already used as training samples) for each class were tested. Table- 2 shows the test results of this strategy. In this table, the best attained results are marked in red.

In Strategy (B) the remaining 30% of samples of each class were tested. This strategy is considered as hard test of the system. Notice here that the 8 classes that have six or less samples are included in this test also, as shown in Table 3. The best attained results are highlighted in red.

For strategy (C), all samples (i.e., 1785) samples are included in this test. This test is considered as a comprehensive test. Table- 4 shows the best attained results that are highlighted with red.

Table 2- Test result for strategy A, where all trained samples were used.

Total Number of tested Samples	True Positive	Percentage	Time (S)	Number of Blocks	Rate of Overlapping	Distance Measure Equation
1318	1310	99.393	0.02	14x14	0.8	3
1318	1293	98.103	0.026	18x18	1	4
1318	1261	95.675	0.019	16x16	0.9	5
1318	1261	95.675	0.019	16x16	0.9	6

Table 3- Test results for strategy B, only the non-training samples were used.

Total Number of tested Samples	True Positive	percentage	Time (S)	Number of Blocks	Rate of Overlapping	Distance Measure Equation
495	493	99.59596	0.005	7x7	0.1	3
495	493	99.596	0.016	14x14	1	4
495	481	97.172	0.01	10x10	0.8	5
495	436	88.081	0.003	4x4	0.4	6

Table 4- Test result for strategy C, where all of the samples were used.

Total Number of tested Samples	True Positive	percentage	Time (S)	Number of Blocks	Rate of Overlapping	Distance Measure Equation
1785	1770	99.160	0.012	12x12	0.8	3
1785	1753	98.207	0.007	10x10	0.1	4
1785	1712	95.910	0.019	16x16	0.9	5
1785	1743	97.647	0.019	16x16	1	6

Depending on strategy (C), the attained recognition rate is 99.159% (i.e., 1770 image sample passed successfully the tests among the total 1785 samples). The best attained result is higher than all of the reviewed literatures. The details of test (C) is presented in Table 5-a and Table 5-b.
In Table 5-a the test results for strategy C is presented, where all of 1785 samples were tested. For this Table the number of blocks was taken from 2x2 to 10x10. For Table 5-b test results for strategy C is presented. In this Table all of the 1785 samples were tested too, while the number of blocks ranges from 11x11 to 20x20.

For both of the two Tables, Table 5-a and Table 5-b, the rate of overlapping ranges from 0 to 1. The documented time is in seconds, which is given as an average time for recognizing a single alphanumeric image.

One can notice that the best recognition rate is obtained when the number of features equals 12x12x2 with rate of overlapping ration reaches to 80%. The average time for the recognition of single alphanumeric is 0.012 second. This result was gained when the distance measure (D_1) was used for testing the similarity between templates features and the corresponding features of the tested input alphanumeric samples. Table 6 shows the details of this obtained result.

6. Conclusions

This paper presents a new method to recognize the letters and numbers of the Iraqi LP. The used method extracts the features from the binary image of the alphanumeric by partitioning it into tiles, then for each tile, the vertical and horizontal projections are determined. A set consists of 1785 images were used test the performance of the proposed method using four different similarity measures. Three test strategies were applied to test the proposed method. The results show that the local vertical and horizontal projections are suitable for representing alphanumeric objects of the Iraqi license plate, it leads to success recognition rate reaches to 99.15966%. By comparing this result with many recent published researches, one can conclude that the proposed method shows the best performance. In future scope this method can be developed and used for scanned images recognition, or handwritten letters and numerals. Also, instead of still images, capturing the plate images from a video to have a real time system may be adopted too.

Table 5-a: Details of test strategy C, with number of blocks ranges from 2x2 to 10x10.

R		Number of Blocks								
		2x2	3x3	4x4	5x5	6x6	7x7	8x8	9x9	10x10
0	TP	1666	1476	1727	1690	1732	1761	1757	1762	1743
	%	93.33334	82.68908	96.7507	94.67787	97.03082	98.65546	98.43137	98.71149	97.64706
	Time(S)	0.001	0.002	0.002	0.003	0.003	0.004	0.005	0.006	0.007
0.1	TP	1519	1594	1720	1710	1744	1762	1746	1758	1755
	%	85.09804	89.29972	96.35854	95.79832	97.70308	98.71149	97.81512	98.4874	98.31933
	Time(S)	0.001	0.002	0.002	0.003	0.004	0.004	0.005	0.006	0.007
0.2	TP	1370	1638	1710	1741	1741	1754	1753	1760	1762
	%	76.7507	91.76471	95.79832	97.53501	97.53501	98.26331	98.20728	98.59944	98.71149
	Time(S)	0.002	0.002	0.002	0.003	0.004	0.004	0.005	0.006	0.008
0.3	TP	1154	1690	1682	1736	1737	1731	1749	1748	1761
	%	64.64986	94.67787	94.22969	97.25491	97.31092	96.97479	97.98319	97.92717	98.65546
	Time(S)	0.002	0.002	0.003	0.003	0.004	0.005	0.006	0.007	0.008
0.4	TP	1059	1704	1656	1721	1744	1722	1763	1751	1757
	%	59.32773	95.46218	92.77311	96.41457	97.70308	96.47059	98.76751	98.09524	98.43137
	Time(S)	0.002	0.002	0.003	0.004	0.004	0.005	0.006	0.007	0.008
0.5	TP	821	1656	1675	1710	1729	1722	1750	1757	1762
	%	45.9944	92.77311	93.83753	95.79832	96.86275	96.47059	98.03922	98.43137	98.71149
	Time(S)	0.002	0.003	0.003	0.004	0.004	0.005	0.006	0.007	0.008
0.6	TP	715	1558	1705	1688	1745	1737	1758	1746	1757
	%	40.05602	87.28291	95.5182	94.56583	97.7591	97.31092	98.4874	97.81512	98.43137
	Time(S)	0.002	0.003	0.003	0.004	0.005	0.005	0.007	0.007	0.009
0.7	TP	685	1404	1696	1649	1743	1730	1760	1738	1755
	%	38.37535	78.65546	95.01401	92.38095	97.64706	96.91877	98.59944	97.36694	98.31933
	Time(S)	0.002	0.003	0.004	0.004	0.005	0.006	0.007	0.008	0.009
0.8	TP	636	1318	1696	1648	1734	1728	1756	1753	1762
	%	35.63025	73.83753	95.01401	92.32493	97.14286	96.80672	98.37535	98.20728	98.71149
	Time(S)	0.003	0.003	0.004	0.004	0.005	0.006	0.007	0.008	0.009
0.9	TP	663	1157	1698	1645	1719	1731	1745	1754	1755
	%	37.14286	64.81792	95.12605	92.15686	96.30252	96.97479	97.7591	98.26331	98.31933
	Time(S)	0.003	0.004	0.004	0.005	0.006	0.006	0.007	0.008	0.01
1	TP	2	1077	1671	1663	1716	1738	1745	1757	1759
	%	0.1120448	60.33614	93.61345	93.16527	96.13445	97.36694	97.7591	98.43137	98.54342
	Time(S)	0.003	0.004	0.004	0.005	0.006	0.007	0.008	0.009	0.01

Table 5-b: Details of test strategy C, with number of blocks ranges from 11x11 to 20x20.

R		Nunmer of Blocks									
		11x11	12x12	13x13	14x14	15x15	16x16	17x17	18x18	19x19	20x20
0	TP	1754	1750	1735	1732	1735	1738	1731	1727	1708	1724
	%	98.26331	98.03922	97.19888	97.03082	97.19888	97.36694	96.97479	96.7507	95.68627	96.58263
	Time(S)	0.008	0.01	0.011	0.013	0.014	0.016	0.018	0.02	0.022	0.024
0.1	TP	1752	1746	1738	1725	1733	1743	1740	1732	1730	1711
	%	98.15126	97.81512	97.36694	96.63866	97.08684	97.64706	97.47899	97.03082	96.91877	95.85434
	Time(S)	0.008	0.01	0.011	0.013	0.014	0.016	0.018	0.02	0.022	0.025
0.2	TP	1759	1753	1753	1747	1742	1736	1737	1738	1735	1735
	%	98.54342	98.20728	98.20728	97.87115	97.59103	97.25491	97.31092	97.36694	97.19888	97.19888
	Time(S)	0.009	0.01	0.012	0.013	0.015	0.017	0.018	0.021	0.023	0.025
0.3	TP	1756	1758	1755	1752	1743	1737	1734	1736	1740	1734
	%	98.37535	98.4874	98.31933	98.15126	97.64706	97.31092	97.14286	97.25491	97.47899	97.14286
	Time(S)	0.009	0.01	0.012	0.013	0.015	0.017	0.019	0.021	0.023	0.025
0.4	TP	1746	1762	1760	1754	1750	1743	1748	1736	1738	1742
	%	97.81512	98.71149	98.59944	98.26331	98.03922	97.64706	97.92717	97.25491	97.36694	97.59103
	Time(S)	0.009	0.011	0.012	0.014	0.016	0.017	0.019	0.021	0.023	0.025
0.5	TP	1746	1764	1758	1758	1753	1746	1753	1740	1739	1731
	%	97.81512	98.82353	98.4874	98.4874	98.20728	97.81512	98.20728	97.47899	97.42297	96.97479
	Time(S)	0.01	0.011	0.012	0.014	0.016	0.018	0.019	0.021	0.023	0.026
0.6	TP	1751	1763	1765	1760	1758	1757	1759	1752	1755	1744
	%	98.09524	98.76751	98.87955	98.59944	98.4874	98.43137	98.54342	98.15126	98.31933	97.70308
	Time(S)	0.01	0.011	0.013	0.014	0.016	0.018	0.02	0.022	0.024	0.026
0.7	TP	1760	1763	1768	1757	1765	1766	1755	1764	1752	1746
	%	98.59944	98.76751	99.04762	98.43137	98.87955	98.93558	98.31933	98.82353	98.15126	97.81512
	Time(S)	0.01	0.011	0.013	0.015	0.016	0.018	0.02	0.022	0.024	0.027
0.8	TP	1761	**1770**	1764	1769	1762	1766	1762	1766	1757	1763
	%	98.65546	**99.15966**	98.82353	99.10364	98.71149	98.93558	98.71149	98.93558	98.43137	98.76751
	Time(S)	0.01	**0.012**	0.013	0.015	0.017	0.018	0.02	0.022	0.025	0.027
0.9	TP	1761	1766	1769	1769	1766	1768	1761	1757	1752	1761
	%	98.65546	98.93558	99.10364	99.10364	98.93558	99.04762	98.65546	98.43137	98.15126	98.65546
	Time(S)	0.011	0.012	0.014	0.015	0.017	0.019	0.021	0.023	0.025	0.027
1	TP	1764	1763	1766	1765	1769	1770	1763	1767	1760	1767
	%	98.82353	98.76751	98.93558	98.87955	99.10364	99.15966	98.76751	98.9916	98.59944	98.9916
	Time(S)	0.011	0.013	0.014	0.016	0.017	0.019	0.021	0.023	0.025	0.027

Table 6- Details of the attained results for the all samples belong to 28 classes. The number of tiles is 12x12 with overlapping ratio (0.08).

Class No.	No. of Samples Per Class	True Positive	%	Class No.	No. of Samples Per Class	True Positive	%
0	88	87	98.864	15	12	12	100
1	126	125	99.206	16	4	4	100
2	198	196	98.990	17	2	2	100
3	97	97	100	18	14	14	100
4	114	113	99.123	19	13	11	84.615
5	99	97	97.980	20	68	66	97.059
6	175	175	100	21	12	12	100
7	130	129	99.231	22	160	159	99.375
8	75	73	97.333	23	3	3	100
9	109	109	100	24	13	13	100
10	4	4	100	25	4	4	100
11	174	174	100	26	3	3	100
12	6	6	100	27	2	2	100
13	13	13	100	Total: 28 Classes	1785	1770	99.15966%
14	67	67	100				

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