Iraqi Plate Number Recognition Using Single Value Decomposition (SVD)

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Abstract

Distinguishing car plate numbers is an important topic of researchers' concern, which assures the process required to be high speed and acceptable accuracy, with the need to access the database and verify it if there was a problem and give a warning if it is necessary. A method is proposed in this paper to distinguish the plate of Iraqi vehicles (new forms), which will prevail in the end, depends on the pre-processing of the image and apply some filters such as (median filter) as well as improving the image before starting the proposed method, which relies on a normalization in the horizontal and vertical direction process and then segment the image into regions. Information is extracted from each region, such as the area that defines the type of vehicle if it is a governmental, private, taxi, or others. The region that characterizes the city as well as Arabic and English, numbers region is segmented and then transform with single value decomposition (SVD) on the image and get features that will send to the database for identification. The proposed method has given a percentage of accuracy of about 90.4 % in the process of discrimination with significant time complexity on average using K-Nearest Neighbor K-NN classifier. It possible to implement the proposed method with application of emergency alarm, to give a warning alert.

Keyword: SVD, affine transform, image segmentation, image enhancement and K-NN.

تمييز ارقام السيارات العراقية بالاعتماد على تحويل تجزئة القيم الوحيدة (SVD)

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معهد الادارة – الرصافة

ألخلاصة

تعتبر عملية تمييز ارقام السيارات من المواضيع المهمة التي تشغل الباحثين اذ تتطلب ان تكون بسرعة كبيرة و دقة عالية وذلك لغرض الوصول الى قاعدة البيانات والتحقق منها اذا كانت هناك مشكلة واعطاء انذار اذا تطلب الامر. في هذا البحث تم اقتراح طريقة لتمييز ارقام السيارات العراقية (الشكل الجديد) والذي سيكون هو السائد في نهاية المطاف. أعتمد على المعالجة الاولية للصورة وتطبيق بعض المرشحات (الفلاتر) مثل (median filter) كذلك تحسين الصورة قبل البدأ بالطريقة المقترحة والتي تتعتمد على اجراء عملية تصحيح الابعاد في الاتجاهين الافقي والعمودي ومن ثم تقطيع صورة الرقم الى مناطق و يتم استخلاص المعلومات من كل منطق، مثل المنطقة التي تحدد نوع الرقم اذا كان حكومي او خاص او عمومي او حمل وحسب اللون المطلوب والمنطقة التي تميز المحافظة وكذلك منطقة الارقام العربية والانكليزية ويتم تمييز الارقام باجراء عملية تحويل SVD على صورة الرقم والتعرف على خصائص وارسالها الى قاعدة البيانات للمطابقة وقد اعطت الطريقة نسبة دقة تصل الى حوالي 91% في عملية التمييز باستعمال خوارزمية الجار الاقرب (K-NN) للتصنيف وفي وقت معدله وممكن تطبيق الطريقة المقترحة مع نظام انذار لاعطاء تنبيه في حالة وجود رقم مشتبه به.

الكلمات المفتاحية: تحويل تجزئة القيمة الوحيدة و التحويل التألفي و تجزئة الصور الرقمية وتحسين الصور الرقمية.

Introduction

Several procedures are merged in most algorithms for number plate localization, which results in a long computational and accordingly considerable execution; applying less and simpler algorithms may reduce this process [1]. The results highly depend on the quality of image, since the procedures reliability severely degrades in the case of noisy, complex pictures that contain a large number of details. The various procedures, unfortunately, barely offer a solution for this problem, the only solution is a precise camera adjustment [2]. In other words, the car should be photographed in a way that the size of the number plate is as big as possible and the environment is excluded as possible. Since the optimum moment of exposure can hardly be guaranteed, the adjustment of the size is especially hard in the case of fast cars. Number Plate Localization on

the Basis of Edge finding [3]. These algorithms rely on the observation that number plates usually appear as high contrast areas in the image [4].

Literature Survey

There are several works deal with licenses plate recognition such as:

- ***Dr. Yaduvir Singh and Mukesh Kumar*** [5] suggest a real-time method which recognizes license plates at gate based on extracting the license plate from a single image, isolating the characters of the plate and identifying the individual characters.
- ***Assist. Prof. Dr. Loay E. George Nada N. Kamal*** [6] suggest a recognition method from three steps; first stage is image binarization and segmentation, the second stage is license plate localization be determined, and the third stage is the license plate recognition distribution based on templet matching.
- ***Bashar M. Nema and Emad A. Mohammad*** [7] suggest a recognition method that compares the license plate with the database of plates that are law enforcement. Plates. It depends on isolation of character, Number that captured under different circumstances such as shadow. It based on back propagation neural network.

Single Value Decomposition

The singular-value decomposition (SVD) is a matrix factorization by decomposition of Eigen value and Eigen vector of the matrix. Symmetric matrix has positive eigenvalues with respect to any matrix via an extension of the polar decomposition. It is useful in many applications such as: signal processing and statistics [8], [9]. SVD takings a rectangular matrix of data, The SVD theorem is:

$$Anxp = U_{nxn}\, S_{nxp} V^{T}_{pxp} \ldots 1$$

Where U_{nxn} isI_{nxn} , U are orthogonal, $V^{T}V$ is I_{pxp},V are orthogonal

SVD characterizes an expansion of the original data in a coordinate system where the covariance matrix is diagonal. SVD signifies an extension of original data using the covariance matrix is diagonal.

Affine Transform

Normalizing of the image is concerning the affine transform. The affine transform called generalized complex moments computed in polar coordinates and their behavior is analyzed in recognition of symmetrical objects [7,8], used factorization of the second order moment matrix to define the normalization constraints.

$$x' = a_0 + a_1 x + a_2 y \quad \ldots 2$$

$$y' = b_0 + b_1 x + b_2 y \quad \ldots 3$$

Where, $x' and\ y'$ are new values, $a_0, a_1, a_2, b_0, b_1, and\ b_2$ are constants.

Image Plate Dataset

The dataset used in proposed method collect by capturing sense of vehicles. The collection of images used from a different position and different distances. It used about 84 images in the proposed method.

Image Classification

Image classification process used pixel based or feature based to distinguish between images or between regions in the same image. Two main classification methods are Supervised Classification and Unsupervised Classification. In supervised classification, there are predefined classes of images called training set. Some of predefined of images used for testing. There are a different kind of supervised classification algorithm such as decision tree method, Bayesian method, or K-NN etc.… K-NN classification algorithm calculates a distance of the input class to each class in the dataset and get the nearest odd number of classes (5, 7, or 9 etc..) for a final decision.

Proposed Method

The Proposed method applied on Iraqi plate number to recognize the plate information. The information are: number, city, and the type of plate.

The proposed method is based on a set of phases; each phase has a special function for giving the car plate information as shown in figure 1.

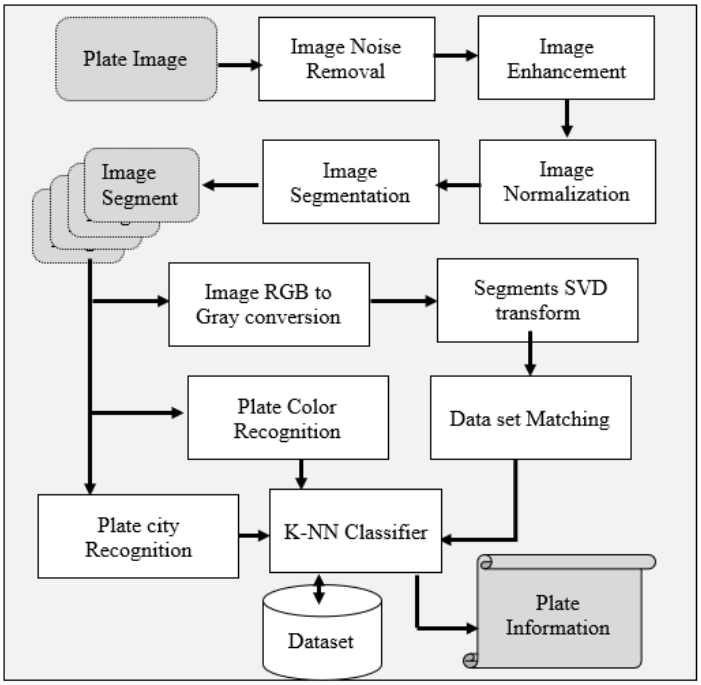

Figure 1: Framework of Proposed Method

Image Noise Removal

For removing the noise from image, the first phase applies a median filter on plate image. The median filter is generally used in digital image processing. It preserves edges while removing noise. The idea of the median filter mainly is to run through the signal entry by entry, replacing each with the median of neighboring entries as shown in figure 3. Note that the median simply a just the middle value if the window has an odd number of entries, then after all the entries in the window are sorted numerically. In case the even number of entries, there is more than one possible median. One of the major advantages of the median filter over linear is it has extremely large magnitudes.

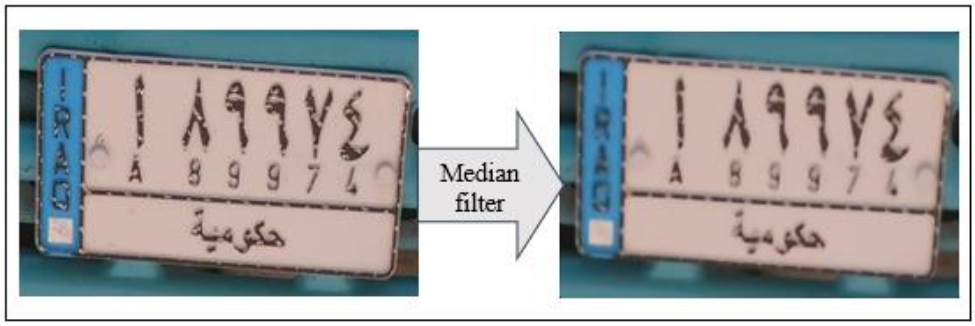

Figure 3: median filter on plate number

Image Enhancement

Enhancement phase is an image sharpening or image contrast adjustment, sharpening of the image is used to explain some details that not clear and increase image contrast. It contrasts called posting filter that enhances the edges. The step is grayscale image histogram equalization, histogram equalization enhances the contrast of images by converting the values in an image pixel as shown in figure 4, or the values in the color map of an indexed image, so that the histogram of the output images nearly a quantified histogram.

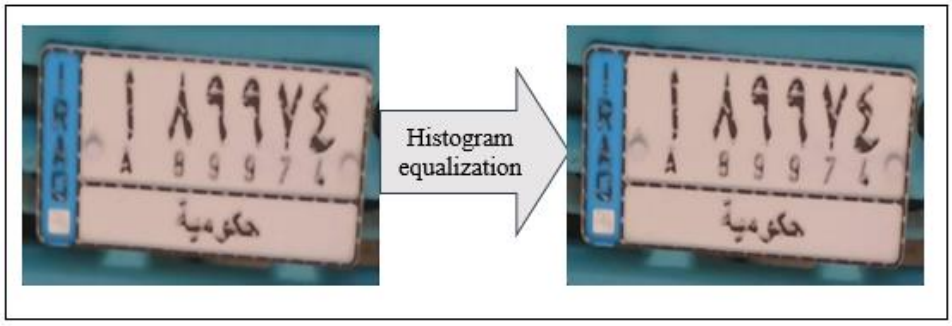

Figure 4: histogram equalization of plate image

The range of histogram value is in [0, 255]. The histogram of the new image (histogram equalization) will be better by changing the intensity image pixels.

Image Normalization

The affine method used for normalization, it a simpler way of normalization to the affine transformation, which is based both on complex moments as well as traditional geometric. Also, the method is well defined for objects that have n-fold rotation symmetry, which is its main advantage as shown in figure 5.

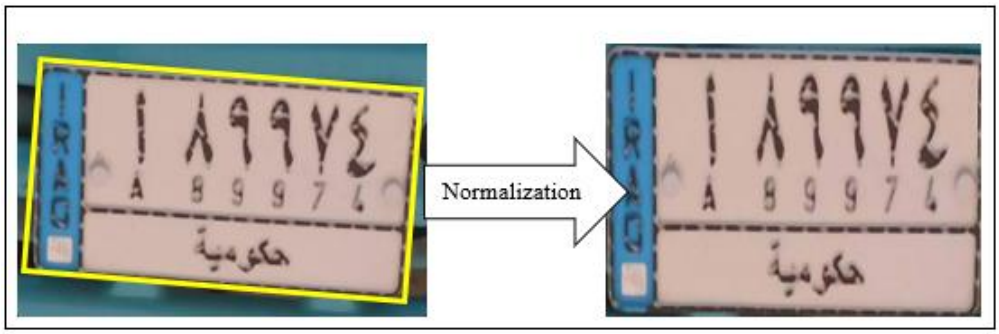

Figure 5: affine transform on plate image

Image Segmentation

This phase splits the plate number into three main regions: number region, color region and city region. The number region consists of Arabic numbers and English numbers. The segmentation depends on the percentage of geometric dimensions of plate numbers, the number region segmentation shown in figure 6.

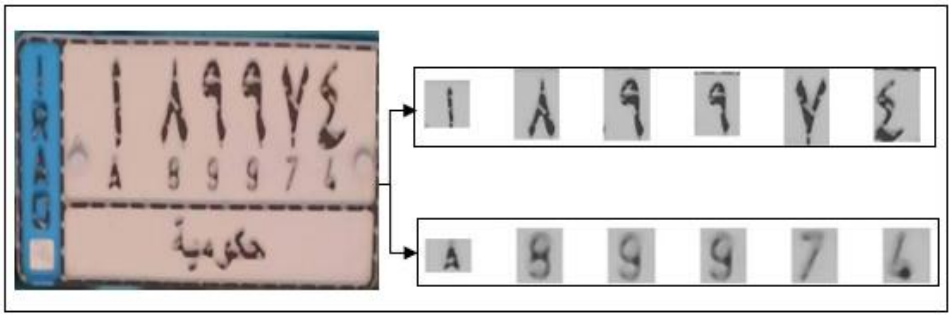

Figure 6: median filter

Image RGB to Gray conversion

The image is changed to image with grayscale format, and then the median filter is applied to remove the noise. As shown above, the original image is converted to an image with grayscale format which has a high contrast. Now, there is a necessity for identifying the location of the number plate horizontally in which row it's present. The numbers and letters are placed in the same row (i.e., at identical vertical levels) which leads to frequent changes in the horizontal intensity for discovering the horizontal changes of the intensity since it is expected for the rows that contain the number plate are to exhibit many sharp variations. The Horizontal intensity graph is as follows, with the peaks indicating high contrast regions in the image.

Plate-Color Recognition

In this phase, the color of plate region needs to be recognized and it depends on the histogram of three color band RGB and specifies the maximum color in the range of each color in the histogram as shown in figure 7.

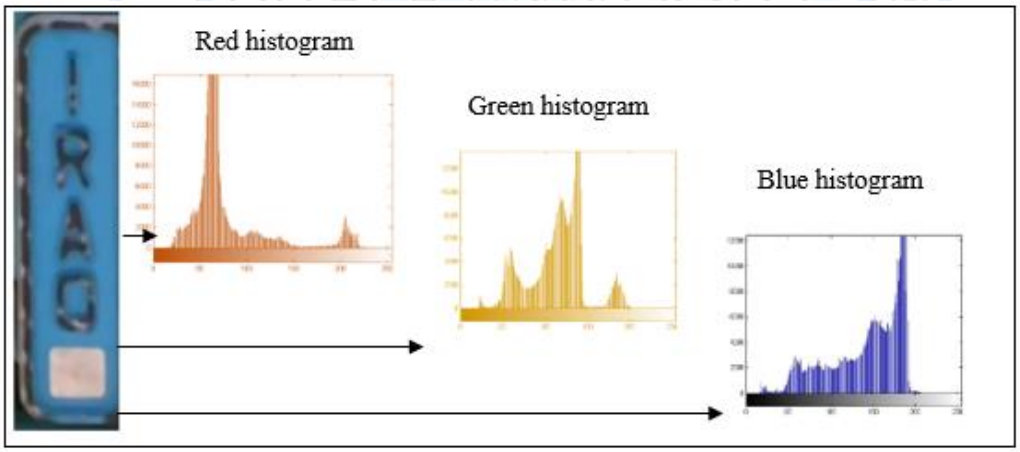

Figure 7: color bands histogram

Plate City Recognition

The city segment is sent to check with dataset have all city names and return the city matching. The matching applied to store database. Highlighting the name of the city takes place by sending the image to the database is the return of an identification number representing the city or a particular number of government cars; as shown in figure 8.

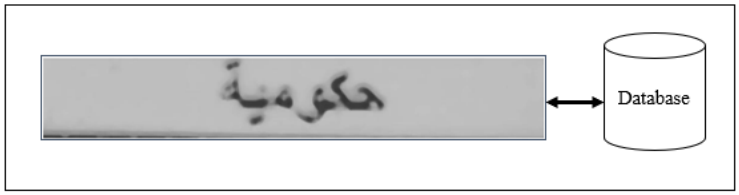

Figure 8: city name identification

Segments SVD transform

This phase is one of the important phases, the image of segment number are transformed using SVD that produce three matrix U, S and V. the middle matrix S contains only diagonal values and the norm of these values are calculated to generate a number that represents a feature which will be sent to database that contains the characteristics of all features. After recognizing the total information, a query sends to another database to ensure the possibility of suspicion required number as shown in figure 10, while tables 1, 2 and 3 represent an example of U, S and V matrix respectively.

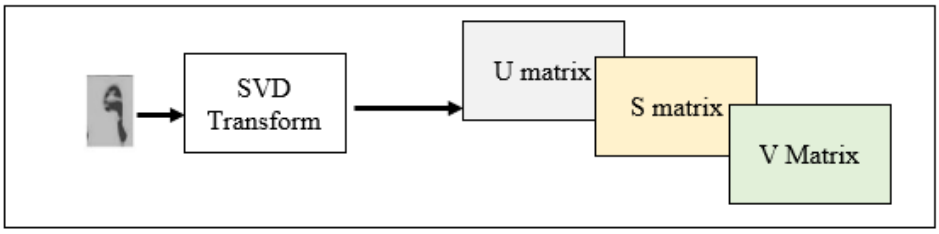

Figure 8: SVD transform

K-NN Classification

The Diagonals of S matrix used as feature extraction used for classification. Each input segment will used this method to extract feature find distances with all classes of the same kind of feature (Arabic or English) digits or letters. The K-NN applied by finding Euclidian distance of the input pattern with all pattern of all classes in database in select an odd nearest pattern (5, 7, or 9). The greater class label will be the prediction label. The total lessened plate will split into training and testing set (80% for training and 20% for testing) to find the best training set (best accuracy).

Table 1: U matrix

-0.0220	-0.0273	-0.0103	-0.0611	0.0499	-0.0338	-0.0163	-0.1812
-0.0220	-0.0272	-0.0105	-0.0610	0.0497	-0.0336	-0.0159	-0.1792
-0.0219	-0.0273	-0.0108	-0.0608	0.0492	-0.0334	-0.0147	-0.1763
-0.0219	-0.0275	-0.0109	-0.0612	0.0491	-0.0337	-0.0138	-0.1753
-0.0219	-0.0276	-0.0109	-0.0615	0.0493	-0.0341	-0.0136	-0.1761
-0.0220	-0.0279	-0.0106	-0.0624	0.0504	-0.0350	-0.0138	-0.1795
-0.0221	-0.0284	-0.0101	-0.0636	0.0516	-0.0360	-0.0141	-0.1833
-0.0223	-0.0289	-0.0095	-0.0651	0.0533	-0.0372	-0.0147	-0.1884

Table 2: S matrix

92151.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10981.58	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	6995.96	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	4180.70	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	3669.79	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	2503.20	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	1900.56	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	1809.96

Table 3: V matrix

-0.0508	0.0253	0.0105	0.0091	0.0142	0.0069	-0.0044	0.0139
-0.0508	0.0251	0.0108	0.0097	0.0147	0.0066	-0.0043	0.0143
-0.0509	0.0254	0.0114	0.0131	0.0165	0.0074	0.0001	0.0137
-0.0509	0.0253	0.0115	0.0133	0.0166	0.0071	-0.0002	0.0137
-0.0509	0.0251	0.0119	0.0138	0.0166	0.0068	-0.0009	0.0145
-0.0509	0.0251	0.0121	0.0142	0.0166	0.0066	-0.0012	0.0157
-0.0509	0.0248	0.0127	0.0148	0.0166	0.0061	-0.0023	0.0165
-0.0510	0.0248	0.0129	0.0152	0.0166	0.0059	-0.0026	0.0176
-0.0510	0.0246	0.0134	0.0158	0.0166	0.0056	-0.0034	0.0185
-0.0510	0.0245	0.0135	0.0159	0.0166	0.0054	-0.0036	0.0185
-0.0511	0.0247	0.0136	0.0151	0.0169	0.0047	-0.0029	0.0217
-0.0511	0.0248	0.0137	0.0150	0.0162	0.0051	-0.0016	0.0228

The Features of each segment (letter or digit) are extracted from S matrix as shown in table 4. These features will normalized and then matching with the same features extract and store them in database.

Table 4: Feature extraction samples

Feature 1	Feature 2	Feature 3	Feature 4	Feature 5	Feature 6	Feature 7	Feature 8
92151.48	10981.58	6995.96	4180.70	3669.79	2503.20	1900.56	1809.96

Experimental Test Results

The implementation of the proposed methods is done on the PC that has processor is Intel (R) COR(TM), i5-2630QM CPU @2.00 GHz 2.00 GHz, the operating system is windows 8 (64 bits x64) and RAM is 4GB. Using MATLAB 2014 is used as software tools. Experiments have performed to test the proposed method and to measure the time-complexity and accuracy of proposed method. The input images are resized in (160x320 pixel) size colored images. The number of samples used in this paper is 84 vehicles, different weather and under various illumination conditions and distance. The success accuracy rate is 90.4 % and the average time required to detect the plate is 116.7808 Sec milliseconds for training as shown in table 5. Some samples of dataset show in Figure 9 that applied in proposed method.

Table 5: Feature extraction samples

Part #	Image # 84	Training Fold				Testing
		Sensitivity	Specificity	Precision	Accuracy	Accuracy
Part 1	67:17	0.9286	0.9001	0.9110	0.9429	0.9314
Part 2	65:19	0.8812	0.8877	0.8521	0.8830	0.8833
Part 3	66:18	0.9111	0.8999	0.9011	0.9002	0.9102
Part 4	70:14	0.8921	0.9212	0.9301	0.8811	0.8714
Part 5	72:12	0.9015	0.9155	0.9109	0.9001	0.9211
Average Time		116.7808 Sec				

Conclusion

A system for Iraqi plate number recognition has been implemented. The recognition idea that is proposed in this paper based on transform single value decomposition (SVD) on the image and get features that will send to the database for identification. The SVD approach is robust, simple easy and fast to implement. It performs well in a constrained environment. It provides a practical solution for the recognition problem. Instead of searching a large image database with the use of bases image, this small set of likely matches can easily obtained. The proposed method has given a percentage of accuracy of about 90.4% in the process of discrimination with significant time complexity at average.

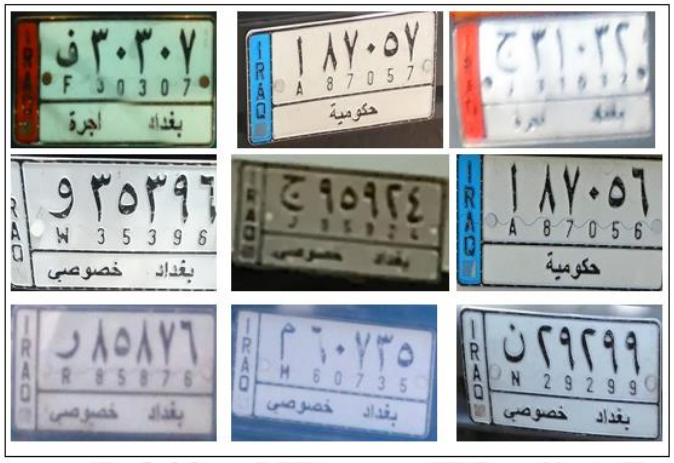

Figure 9: images plate used in proposed method

References

1. Tran Duc Duan, Tran Le Hong Du, Tran Vinh Phuoc, Nguyen Viet Hoang "***Building an Automatic Vehicle License-Plate Recognition System*** ", Febraury 2005.
2. CheokMan, Kengchung "A High Accurate Macau License Plate Recognition System", 2008.
3. R Thuy Tuong Nguyen, Xuan Dai Pham and Jae Wook Jeon"Rectangular Object Tracking Based on Standard Hough Transform ", February, 2009.
4. Yungang Zhang Changshui Zhang "A New Algorithm for Character Segmentation of License Plate", June 2003.
5. Mukesh Kumar," A Real-Time Vehicle License Plate Recognition (LPR) System", M.Sc. Thesis, Roll No-80751015, Thapar University, India, JULY 2009.
6. Assist. Prof. Dr. Loay E. George and Nada N. Kamal, "Real Time Recognition and Tracking of Iraqi Vehicle License Plate", M.Sc. Thesis, College of science, Baghdad University, Iraq, March 2013.
7. Bashar M. Nema and Emad A. Mohammad, "Iraqi License Plate Recognition System", International Journal of Digital Content Technology and its Applications (JDCTA) Volume10, Number2, March 2016.

8. Wenjing Jia, Huaifeng Zhang, and Xiangjian He Mean Shift for" Accurate Number Plate Detection", July 2005.

9. Nafis uddin Khan;K.V. Arya; Manisha Pattanaik, "An efficient image noise removal and enhancement method", 2010 IEEE International Conference on Systems, Man and Cybernetics , IEEE, ISSN: 1062922X , Pages: 3735-3740 , 2010 .

10. Chris Solomon; Toby Breckon, "Fundamentals of Digital Image Processing", Wiley Blackwell, 2012.

11. Linda Shapiro, "Computer Vision", Prentice Hall, January 2001.

12. Tinku Acharya; Ajoy K. Ray, "Image Processing Principles and Applications",

13. Wiley, 2005.