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Distinguishing license plate numbers using discrete wavelet transform technology based deep learning

Asma Abdulelah Abdulrahman, Fouad Shaker Tahir
Department of Applied Sciences, University of Technology, Baghdad, Iraq

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ABSTRACT

Cars that violate the red light, and to increase the huge number of cars in violation, it is necessary to discover a system for identifying car plate numbers with the intervention of a computer, computer vision and neural networks segment and detail the number plates by designing regular algorithms to identify the number of license plates in violation. In this work, interest is in identifying the Iraqi car plate in order to know the place where the vehicle papers and the letters on which the vehicle depends and to know the location of the car were completed. The technique that was carried out in this work is to build new wavelets from polynomials by mathematical methods and discover a new algorithm using the MATLAB program to identify each number in the vehicle plate with a specific color by training a convolutional neural network (CNN) after analyzing the image using the new wavelets to identify the contents of the plate and good results have been reached. The accuracy level was reached with good values of up to 95%.

Corresponding Author:

Asma Abdulelah Abdulrahman
Department of Applied Sciences, University of Technology
Baghdad, Iraq
Email: asma.a.abdulrahman@uotechnology.edu.iq

1. INTRODUCTION

In recent years, the need for automatic identification of vehicle license plates, for example, in parking spaces, led to intelligent identification of the vehicle, opening gates, and also monitoring traffic violating vehicles. Finally, it is allowed to limit the speed of vehicles on the highways and the need to identify or identify the vehicle plate led to the rapid and automatic payment of fees to develop reception and transmission through the image of the vehicle and identification of the plat. Discover a system that leads to the immediate identification and arrest of the traffic violation driver who handled the potential bribery cases [1]. An algorithm has been developed for automatically identifying vehicle numbers on the Beagle Board, where the technology for identifying vehicle numbers has been highlighted and activated in military areas. It was noted that the developed system successfully detects and recognizes the vehicle's number plate on real photos.

The algorithm was completed in three stages, starting with the camera, after which the numbers and text of the plate were determined. Finally, the data of the owner of the vehicle was taken to reach the violating vehicle [2]. Vehicle plate detection in [3] used image processing with rapid convolutional synthetic network to detect vehicle localization. The automated car system has been described in which the driver's face is recognized to prove his identity at the entrance and exit by means of obtaining a picture of the car with the driver with the detection of the car with the driver's face [4]. It was applied in the identification of the car plate by suggesting the division of the application to the first plate to be maximal stable extremely region (MSER) and to determine the plate of the vehicle [5], [6]. The plates of Chinese vehicles have been identified by proposing a method distinct with its power in which afne transformations are used in discovering the plate and

avoiding errors to identify the plate of the Chinese vehicle, deep learning is the best method for automatic identification [7]. Traffic applications in roads and parking lots automatic license plate recognition (ALPR) system was used [8]. Cameras that are available at intersections where plates are identified in three stages: identifying the vehicle, identifying the plate and then recognizing the license plate of the vehicle [9]-[12]. In [13]-[15] the first stage is the discovery of the vehicle in natural conditions and clearly, the second stage is the discovery of the plate of the discovered car (LP). It is common to detect the user of the vehicle (LPD) [16]. In [17]-[22] the problem of selecting panels without detecting edges has been addressed. In general, the license plate detected is identifying the number. As for the methods of identifying the personality, there are two types. The plate letter is hashed [23] and the second is in [24]-[27], is the end of the discovery process. Despite the development in technology, the discovered systems are all from the front and are limited [28], [29].

This paper was organized first, initializing the new discrete wavelet transformations derived from orthogonal aqueous polynomials in previous works that proved their worth in image processing and proving their mathematical aspects discrete laguerre wavelet transform (DLWT) [30]-[36]. Secondly, training the neural network AlexNet. The new filter will be connected to the work of the convolutional neural network (CNN) associated with the new filter, and its name will be discrete laguerre convolutional neural network (DLCNN) and it will be used to discover the plates of vehicles on highways and public roads in Iraq and license plates. Are they of Iraqi origin or otherwise, in order to control the violating cars? The proposed algorithm is efficient in the speed of accuracy and the results obtained after using the new filter in the used network that were compared with the results before using the new filter and the accuracy of the accuracy was measured. The result was better in terms of value and time. As for the color image quality standard, the best results were obtained in terms of peak signal of noise ratio (PSNR), bit per pixel (BPP), compression ratio (CR), mean square error (MSR) in MATLAB program.

2. RELATED WORK

The detection on the plates of Chinese vehicles has been studied and a proposal for detection is made in a way that the noise can be removed from the vehicle plate using the transformation (afne) accurately with the knowledge of the driver's data. ALPR's mission is to find and identify LPs in nature scenes. It is usually divided into three subtasks. They form a system of 3 consecutive modules: vehicle detection, licensing plate detection, license plate recognition. The basis of ALPR is a powerful detection method. Experts and scientists have conducted extensive research in this field. Several different ALPR methods or related subtasks have been proposed in the past compared with vehicles.

3. METHOD OF RESEARCH

In this work, a method has been proposed to detect the vehicle plate in three stages. The first stage is to build the new filter produced from DLWT low pass filter and high pass filter and equip the MATLAB program with the proposed filter analyses the color image for approximate coefficients the band of low low (LL) and details coefficients for three bands high low (HL), low high (LH) and high high (HH) band that means the color image under the effected the new filter will be divided for four bands LL, HL, LH, and HH used set partitioning in hierarchical tree (SPIHT) method in MATLAB program DE noised image and compression image read the PSNR, BPP, CR, MSR in MATLAB program. Figure 1 vehicle number plate analysis**.**

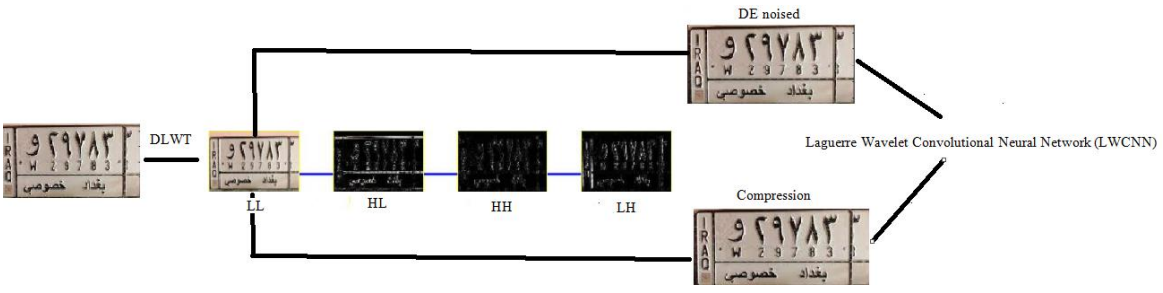

Figure 1. Vehicle number plate analysis

The second stage deep learning for train the AlexNet neural network and build the CNN by using the new filter to form a new CNN. Laguerre wavelet convolutional neural network (LWCNN) hidden layers and

connected layers. The third stage is to build a program to identify the vehicle plate and license the vehicle and know the origin of the plate in order to identify the driver who drives the vehicle to monitor violations on public roads and highways.

3.1. Discrete laguerre wavelet transform

Constructing wavelets for discontinuous fissures that depend on the basic wavelet that depends on two operators (c, d) as shown in (1):

$$W_{c,d} = |c|^{\frac{-1}{2}} W\left(\frac{t-d}{c}\right) \qquad c, d \in R, \quad c \neq 0 \tag{1}$$

then $W(t) = [W_0(t), W_1(t), \dots., W_{M-1}(t)]^T$ the bases $W_0(t), W_1(t), \dots., W_{M-1}(t)$ are orthogonal on the [0,1]. DLWT, $LW_{u,v}(x) = LW_{t,u,v,b}(x)$ then $b = 1,2,..,\ \ u = 1,2,\dots, 2^{b-1}$, v the effect of Laguerre polynomials t is the time.

The following transforms from (1). $c = 2^{-(b+1)}$, $d = 2^{-(b+1)}(2v-1)$, and $x = 2^{-(b+1)}(2^b t)$ (2) will be the mother wavelet for La guerre polynomials in (2),

$$LW_{u,v}(t) = \begin{cases} 2^{\frac{b-1}{2}} \tilde{L}_v(2^b t - 2u + 1) & \frac{u-1}{2^{b-1}} \leq t \leq \frac{u}{2^{b-1}} \\ 0 \end{cases} \tag{2}$$

where $\tilde{L}_v = \frac{1}{u!} L_v \qquad b = 2$

And the approximation function in $L^2[0,1]$:

$$f(t) = \sum_{u=1}^{\infty} \sum_{v=0}^{\infty} z_{u,v} LW_{u,v}(t) \tag{3}$$

$$Z_{u,v} = \langle f(t), LW_{u,v}(t) \rangle \tag{4}$$

the infinite the (4),

$$f(t) = \sum_{u=1}^{2^{b-1}} \sum_{v=0}^{M-1} Z_{u,v} LW_{u,v}(t) = Z^T LW_{u,v}(t) \tag{5}$$

the resulted vector of Z and LW(t) the matrices by given $2^{b-1}M \times 1$

$$Z = \left[Z_{1,0}, Z_{1,1}, \dots, Z_{2,0}, \dots, Z_{2,(M-1)}, \dots, Z_{2^{b-1},0}, \dots, Z_{2^{b-1},M-1}\right]^T \tag{6}$$

$$LW(t) = \begin{bmatrix} LW_{1,0}, LW_{1,1}(t), \dots, LW_{1,M-1}(t), LW_{2,0}(t), \dots, \\ LW_{2^{b-1},M-1}(t), \dots, LW_{2^{b-1},0}(t), \dots, LW_{2^{b-1},M-1}(t) \end{bmatrix}^T \tag{7}$$

3.2. Laguerre wavelets convolutional neural network

In the deep learning and training of the CNN in this work, the proposed DLWT is linked in this work as a development of a regular CNN connected locally in the neural network. The neuron in the field of artificial intelligence is similar to the neuron in the human brain in the connection blister of cells in the neural network in the hidden layers here. When connecting the proposed new wavelet with the CNN derived from Laguerre polynomials to obtain the new developed discrete convolutional network discrete laguerre wavelets convolutional neural network (DLWCNN) to be used in processing color images. In (8) can be interpreted or it shows the effective role of the new filter resulting from the new transformations associated with the three channels of the color image, which indicates that the resulting filter (3×3) based on Laguerre (for LF), LF= (LF, HF, number of channels).

For each pixel the new filter is identical to the channels of the color image after derivation of the new filter by one of the methods either by integrals or by factoring (u,v) in the laguerre filter (LF) equation by the filter in the convolution (8) and (9).

$$C(I, LF)_{x,y} = \sum_{u=1}^{N_H} \sum_{v=1}^{N_W} \sum_{R=1}^{N_C} LF_{u,v-R} I_{x+u-1,y+v-1,R} \tag{8}$$

$$\dim\big(C(I,R)\big) = \left(\left[\frac{v_H + 2P - LF}{S} + 1\right]\right) \qquad S > 0; \tag{9}$$

Then, for $S = 1$, in (9) is reduced to (10):

$$(u_{CH} + 2P - FL_W + 2P - FL) \quad (10)$$

the output size of a CNN, n. P = 0 where $P = \frac{F-1}{2}$ with the hypothesis F=1 which leads to convolution 1×1 To distinguish the image in the process of reducing and merging by specifying the information in each channel that depends on the dimensions (s_H, s_W) in Figure 2.

In (11) shows the channels after using the new filter.

$$\dim\big(P(I,K)\big) = \left(\left[\frac{r_L+2P-F}{S}+1\right], \left[\frac{r_W+2P-F}{S}+1\right], r_C\right) \qquad S > 0; \quad (11)$$

If $S = 1$, in (11) will be reduced to (12).

$$(r_H + 2P - F, r_W + 2P - F, r_C) \quad (12)$$

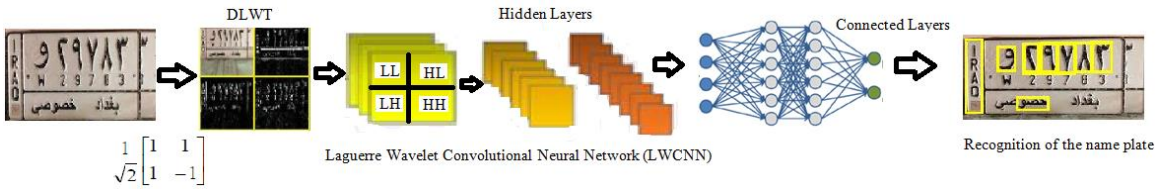

Figure 2. Represents the DLWT with CNN

4. RESULT DESCUTION

By using the wavelets proposed in this work after connecting them with the CNN and after training the neural network in the MATLAB program, high accuracy was obtained before and after using the new technique in Figure 3, after analyzing the image using the new wavelets to identify the contents of the plate and good results have been reached. The accuracy level was reached with good values of up to 95%. The image quality has a parameter to depend on which are PSNR, BPP, CR, and compared with another discrete wavelet transform (DWT) stander or example Symlet, Haar, and daubecheis in Table 1. It turns out that the results obtained through the use of DLWT are much better than the results obtained after using other wavelets and after applied new discrete wavelet transforms effectively affect the improvement of results in image quality parameters in Table 2.

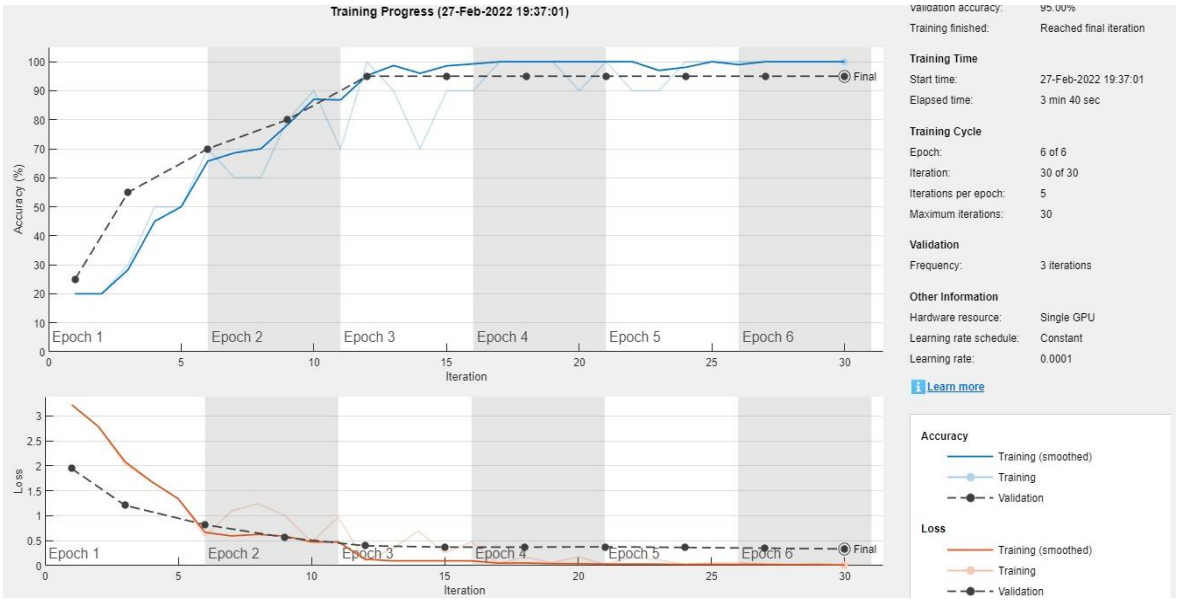

Figure 3. The accuracy with DLWCNN

Table 1. Comparison results between DLWT and Symlet, Haar and daubecheis

DWT	Haar	db	SYM	DLWT
MSE	316.40	316.40	375.60	1.205
PSNR	23.13	23.13	22.38	45.33
B.P.P	0.29	0.29	0.35	6.50
CR	1.25%	1.25%	1.48%	27.12%

Table 2. The results in image quality parameters

The plate name	Detected plate name with CNN	Detected plate name with DLWCNN
		
MSE	0.04	0.02
PSNR	61.15	66.5
BPP	12.02	14.3
CR	50%	55%

5. CONCLUSION

The discovery of a system for recognizing car number plates by using a computer, computer vision, and neural networks, and detailing their number plates by design. Systematic algorithms to determine the number of license plates in violation. In this work, a new and advanced method is proposed to develop a convolutional neural network to obtain the best and fastest results required in determining vehicle numbers for traffic control, vehicle movement in highways and parking lots based on the discrete wavelet transformations derived from the observed wavelets. Laguerre polynomial After training a CNN without waves and after linking the Wavelet framework, the technique implemented in this work is to build new waves of polynomials by mathematical methods and discover a new algorithm using MATLAB program to identify each number in the car plate with a specific color by training a CNN next. Image analysis using new waves to identify the contents of the painting and good results were reached. The accuracy level has been reached with values as good as 95%.

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BIOGRAPHIES OF AUTHORS

Asma Abdulelah Abdulrahman she works in Applied Science, University of Technology/Baghdad. The languages she uses are Arabic-English. She has completed her BS in Department of Mathematics, University of Technology 2007. She has completed her M.Sc. in Optimal control Method, Applied Mathematics, University of Technology, 2012. She has completed her Ph.D. in Image processing/Applied, Mathema Acharya Nagarjuna University, 2019. More than ten research papers have been published in the field of applied mathematics. She has 15 published papers in the fields of image processing, neural networks, and artificial intelligence. She can be contacted at email: asma.a.abdulrahman@uotechnology.edu.iq.

Fouad Shaker Tahir he works in Applied Science, University of Technology/Baghdad. The languages he uses are Arabic-English. Bachelor's degree from the University of Technology, Electrical Engineering Department in 1984. He has completed his M.Sc. in Applied Mathematics, University of Technology, 1998. He has completed his Ph.D. in Artificial Intelligence Algorithms and Digital Systems, University of Technology, 2004. He interest in artificial intelligence and work in this field and image processing. He can be contacted at email: fouad.s.taher@uotechnology.edu.iq.