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The Effectiveness of Discrete Hermite Wavelet Filters Technique in Digital Image Watermarking

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ABSTRACT

Security in the transfer of personal information has become important when transferring it over the Internet, after processing well to maintain the security of the information. The watermark is used, which is an appropriate technique to increase security, transfer and authenticate data

Development in the transfer of information and the necessity of confidentiality to avoid non-imitation of products or to avoid forgery. The importance of the watermark has emerged, which is the integration of the watermark image with the color cover image, which leads to protection from image data to prevent illegal repetition. The goal of the watermark here is to show the role of the waveform is clear and important to immerse the mark in the cover image in the field of waves that help not to distort the watermark and the cover image. Symlets ... etc. New wavelet transformations derived from polynomial, which were built to obtain Discrete Hermite Wavelet Transform (DHWT), and prove their efficiency for use in the image processing by proving the important theorems that have been achieved. In this work, the role of the new and proposed waveforms in dealing with the watermark with the color image is clarified, and a program was created using the MATLAB program by creating a sub program for building the new wavelet and proving their efficiency in the analysis. Color image. The process is repeated using (DHWT) to analyze the image. The image is for different attacks Salt and Pepper% 1, JPEG Compression, etc., then the watermark is retrieved from the image after comparing it with the proposed algorithm and it has proven its power faster and better than previously suggested methods.

The final conclusion shows that by using new wavelets DHWT better PSNRs can be obtained and that the proposed algorithm fills in better the lack of awareness of the watermark and its strength under different attacks.

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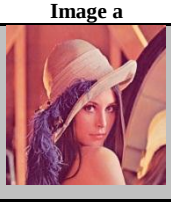
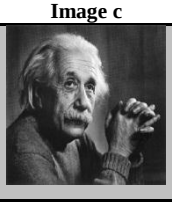
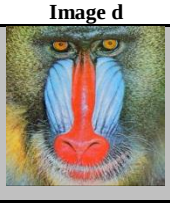
1. INTRODUCTION

The development in Internet technologies leads to the development and ease of processing digital images without loss and preservation of image data [1].

One of the methods used to conceal the information is the watermark to ensure ownership of the product. The procedure is to provide a picture so that the confidential information is immersed in the image of the host [2-4]. the watermarked is retrieved by applying the reverse of proposed

embedding algorithm and extracted watermark is still recognizable. The experimental results confirm that watermark is robust against three types of attacks which are addition of gaussian noise, JPEG compression, and rotation process [5]. In [6] R. Ahuja and S. Bedi adapted a technique which apply on moving picture expert groups, standard (MPEG-2), DCT coefficients are choose rapid decoder frames for watermarking purpose. CandidateI-frames are selected to accomplish good perceptibility and strength. Candidate frame is determined by secretkey which constructed by cryptographic procedure. Extracted watermark is done by using three keys, the first key is used to halt extraction procedure, and the two other two keys are used to demonstrate the scrambled watermark. The robustness is measured by estimate the spatial and temporal synchronization attacks. High robustness is done against video specific often occurs attacks, high watermark capacity obtained by hosted thousands of bits in one frame. Through the Internet, people can copy, process, and transmit videos of interest at will, which brings great convenience to people [7]. recovered inserted watermark image from cover image and compared the quality of the recovered watermark by the correlation coefficient. Robustness of the proposed algorithm is comparatively better than some of the previously proposed methods [8]. One application of digital watermarking is *source tracking*. A watermark is embedded into a digital signal at each point of distribution NCC remains above tolerance level even when the image is completely distorted and also the visual quality of extracted original image is indistinguishable. It can be used for various applications like copyright protection,[9]. With the hasty expansion of technologies of multimedia, and internet of things, people are giving more devotion to the safety of digital audio, images and videos [10-11]. Growing quantity of digital videos which are transferred shared and exchanged over the Internet causes an illegal copying and defective distribution of digital video content, and this considered serious problems [12]. In [13] was applied the DWT on the image and embedded the QR factorized watermark in the LL band of the image and different wavelet filters are applied at the time of watermark insertion and extraction. Comparative study has been also performed to judge the suitability of the scheme, in terms of robustness and quality, on different wavelets for watermarking of color images with matrix factorization. The results are tested in term of extracted watermark quality and watermarked image quality [14]. The training of convolutional neural networks has taken its role in many works that have been identified and studied and their role in image processing and face recognition and their use in the fields of medicine, airport security and wishful thinking. [15-18]. In [19] F. Layth Malallah *et al.* introduced watermarking in video based on arnold transform and integer wavelet transforms (IWT). IWT is used to de-compose the cover frames, and arnold transform is employed to scramble grey scale image watermark. Embedding made transmission more secure by disordering the information by scrambling the watermark before embedding. System performance is compared with some related video watermarking systems, in which the assessment procedures contain testing against some video processes and attacks. Accordingly, the system proved to be robust perfectly. [20] to fulfill security, robustness, and imperceptibility of watermarking exigencies. In [21-22] a factori-zation method LU decompose a matrix into a product of two ma-trices, an upper triangular matrix and a lower triangular matrix such that the main diagonal equal to 1. Solving this problem, the benefits of which are summarized in authentication Data and copyright protection, so that the process is in two stages, is to hide the watermark information and restore it. The most important method used, which has a major role in this field is the field of discrete wavelet transform applications have increased very quickly in the use of digital images. [23-27]. In this work, new wavelets were used that were derived from Hermit's polynomials, and many theories were proven to prove their suitability for dealing with images for use in this field. A new program and algorithm was built that helps equip the MATLAB program with new wavelets to take its role in implementing many applications in the field of images. And in this work it was used with the watermark and QR technology. Table 1 shows the watermark and images used to test the proposed algorithm.

Table 1 shows the watermark and images used to test the proposed algorithm.

watermark	Image a	Image b	Image c	Image d
				

2. RESEARCH METHOD

The aim in this work is to introduce new wavelets to be generated from Hermet polynomials and to use the parent function in wavelet derivation DHWT in addition to propused a new and fast algorithm to show the role of these new wavelets in dealing with the blind watermark , used of a matrix decomposition method called QR algorithm Which boils down to three steps, the first stage is the implementation of Gram-Schmidt to find the orthogonal vectors that form the basis of the wavelet space W of the vector V, to be used in the second stage as columns of composition Q final step solved equation $Q^T A = Q^T(QR) = IR = R$ and the effect of wavelet analysis of the image. Colorful. The QR matrix is affected by the LH block of the image under the influence of the new wavelets DHWT , so that the PSNRs are obtained with the best results after proposing two new algorithms so that the proposed method is not affected by the watermark under the influence of different attacks, table 2 shows the decomposition Lena with QR Factorization And And the logistic map is a second-degree polynomial whose behavior is chaotic for nonlinear dynamic equations so that its mathematical definition depends on the two values s and $\log i_0$ in equation (1)

$$x_{i+1} = sx_i(1 - x_i) \qquad \text{where } x_i \in (0,1) \qquad (1)$$

Table 2: Lena Image Decomposed by QR Factorization

2.1 Discrete Hermite Wavelet Transform (DHWT)

A lot of research included how to construct the wavelet, which consists of the mother function, where the movement depends on two important coefficients a and b, through which the extension and the first translation is responsible for the extension and the second of the translation where the process is continuing on this case:

$$h_{a,b}(x) = |a|^{\frac{-1}{2}} h\left[\frac{x-b}{a}\right] \quad a,b \in R, \ a \neq 0 \qquad (1)$$

where $h(t) = [h_0(t), h_1(t), ..., h_{M-1}]^T$

The elements $h_0(t), h_1(t), ..., h_{M-1}(t)$ are the basis functions, orthogonal on the [0,1].

Let dilation by parameter $a = 2^{-k}$, translation by parameter $b = (a(2n-1))$ and transform $x = a(2a^{-1}t)$, by substitute parameters a, b and transform x in equation (5) , then will be get equation (1).

DHWT $h_{n,m}(t)=h(k,n,m,t)$ include four parameters, $n=1,2,...,2^k$ k is assumed any positive integer, m is the degree of the Hermite polynomials and t independent variable in $[0,1]$.

$$h_{n,m}(t)=\begin{cases}2^{\frac{k}{2}}H_m^*\left(2^{k+1}t-2n+1\right) & t\in\left[\frac{n-1}{2^k},\frac{n}{2^k}\right]\\ 0 & otherwise\end{cases} \quad (6)$$

where $$H_m^*=\frac{1}{2^m m!\sqrt{\pi}}H_m \quad (7)$$

$m=0,1,2,...,M-1$ $n=0,1,2,...,2^k$

The new used of proposed wavelets are applicable in analyzing the color image in both the horizontal and vertical directions and by using the wavelet filter through its low and high passes on the rows of the image and then on the columns separately.

DHWT is applied on a 4×4 sub-image for more illustration**.** The coefficients of DHWT obtained above are used where the filter extracted is

(2×2) F= $\frac{1}{\sqrt{\pi}}\begin{bmatrix}1 & -1\\ 1 & 1\end{bmatrix}$ in figure (1)

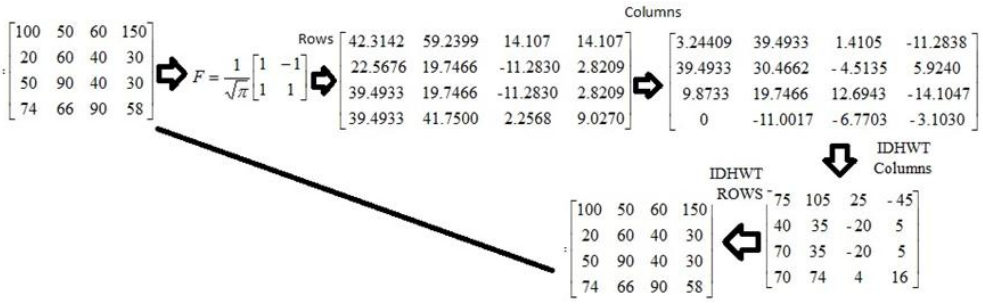


Figure 1. Multi Resolution Analyses (MRA)with DHWT

Figure (2) represents the process of analyzing the image, which shows the division of the image into four parts, LL is the approximate coefficients, HL,LH and HH they are represented details coefficients [28-33]

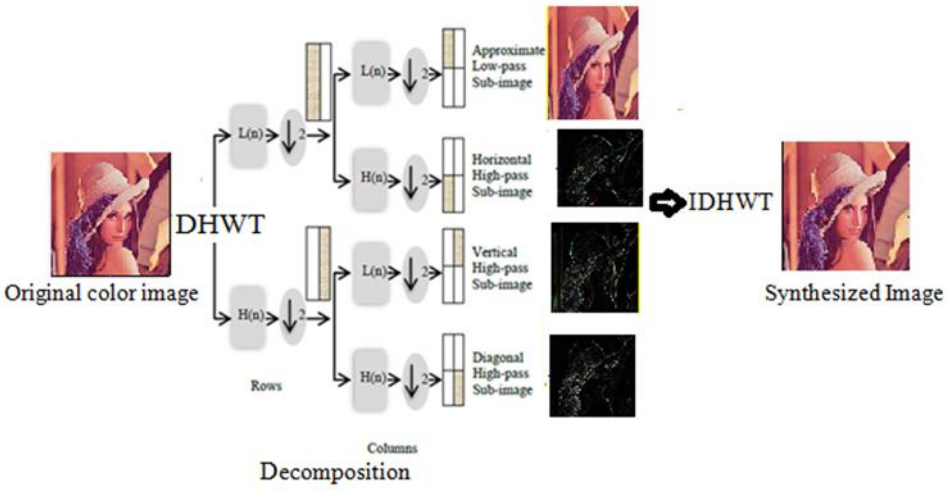


Figure (2) represents the process of analyzing the image with DHWT

2.2 Watermarking Algorithm with DHWT and QR

In this section, the two proposed algorithms will be implemented using new wavelets DHWT which had a major and important role in image analysis, and the two algorithms are in three stages. The first is in which they are included.

Watermark to expose the image with the watermark to several attacks. Figure (3) Embedding Scheme using DHWT and QR Using Logistic Map to increase algorithm security by mixing blocks

2.3 Watermark Embedding Algorithm using DHWT and QR

Steps of embedding with new discrete hermit wavelet transform (DHWT)

Step 1: Insert the color image that has a size $M \times M$, and using MATLAB, the color image will be converted to gray scale

Step 2: The image is analyzed using DHWT

Step 3: The block (LH2) is divided into 2×2 blocks to be the number of blocks $N \times N$

Step 4: In this step, the watermark $N \times N$ is inserted, after which the image is converted into binary

Step 5: The locations are switched for blocks after applying the logistic map as in the equation ()

$$i + 1 = s(1 - x_i) \quad (8)$$

Step 6: **Applied algorithm then A= for decomposition to each block.**

Step 7: The sub-matrix R is used to include the binary watermark bits in this matrix from step 6

$$\mathrm{R}(2,2) = \mathrm{R}(2,2) - \mathrm{R}(2,2)(\mathrm{mod.\,r}) + T_1 \quad \text{if w=1} \quad (9)$$

$$\mathrm{R}(2,2) = \mathrm{R}(2,2) - \mathrm{R}(2,2)(\mathrm{mod.\,r}) + T_2 \quad \text{if w=0} \quad (10)$$

Where r=20.532 is the single scaling factor which controls the tradeoff between imperceptibility and robustness of the proposed watermarking scheme, $T_1 = 0.75S, T_2 = 0.25S$.

Step8: in this step used $=QR$ and logistic map to get watermarked image

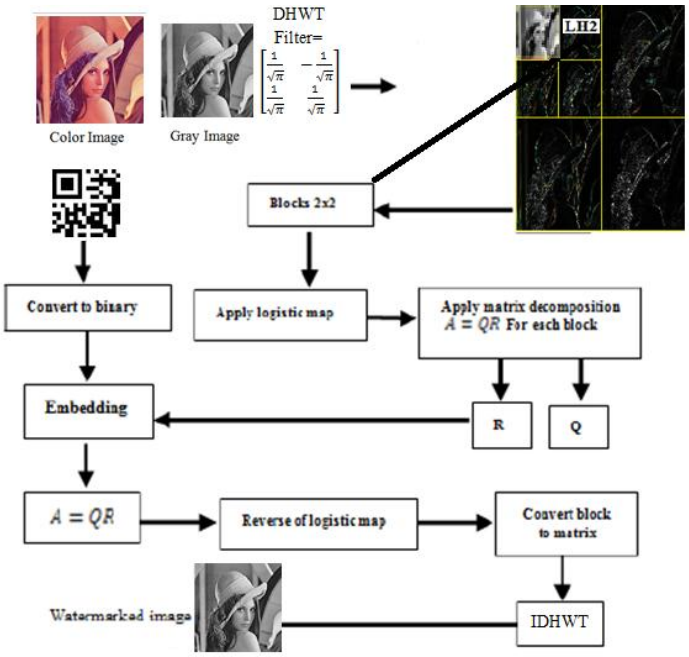


Figure 3. Demonstrates the steps of an embedding algorithm for watermark using (DHWT)

2.4 Watermark Extracting algorithm using DHWT and QR

The algorithm shows the detailed watermark extraction steps:
Step1: The step begins with the watermarked image, which is sized $(M \times M)$ and using the new conversion DHWT convert the image to gray
Step2: The second level watermarked image is analyzed using (DHWT)
Step3: The part (LH2) is chosen and it is divided into two parts (2×2) to be the number of blocks $(N \times N)$
Step4: The parts are restored to their original position by applying the chaotic function (logistic map).
Step5: The matrix A=QR decomposes all parts of the image
Step6: From the R sub-matrix the binary watermark is extracted

$$w = 0 \;\; if \; (\mathrm{T1} + \mathrm{T2})/2 \; < \; \mathrm{mod}\,(\mathrm{R}\,(2,2)) \qquad (11)$$
$$w = 1 \; if \; (\mathrm{T1} + \mathrm{T2})/2 \; \geq \; \mathrm{mod}\,(\mathrm{R}\,(2,2)) \qquad (12)$$

Figure 4 illestrated algorithm with demonstrates the steps of an extracting

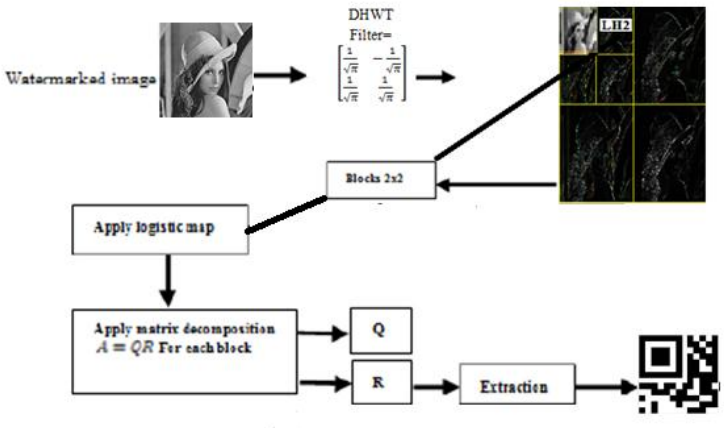


Figure 4.Demonstrates the steps of an Extracting algorithm for watermark using (DHWT)

3. RESULTS AND DISCUSSION

Through the experiments carried out to evaluate the results, the strength of the proposed watermark algorithm and the proposed new wavelet effect. The technique and effect of the wavelet DHWT are examined with a watermark on the proposed images using cover images and then converted to grayscale size 512 x 512. To be done, divide it into 64 x 64 binary chunks as an image watermark.

The results obtained by testing the strength of the proposed algorithm due to the strength of the new wavelets after exposing the watermark image to types of attacks. Table () shows the original used images, the watermark image, and the image with the watermark

Image watermarking technology measures its performance by measuring durability, anonymity, complexity of calculation, etc. One of the criteria for image quality PSNR is the watermark vision assessment test represented by the equation (13)

$$PSNR = 10 \log 10 \left(\frac{MAX^2}{MSE}\right) \quad (13)$$

$$MSE = \frac{1}{ij}\sum_{x=0}^{i-1}\sum_{y=0}^{j-1}[I(x,y) - J(x,y)]^2 \quad (14)$$

The value of the gray scale is equal to 256, which is the maximum number represented in MAX in equation W is the watermark, it is calculated based on NC (a normalized correlation) between W and W′.

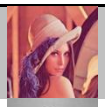
The benefit of the new wavelets Discrete Hermite wavelet Transform (DHWT) is used in two levels on the cover image in the four bands LL2, LH2, HL2 and HH2 to be included in LH2 to be divided into 2 x 2 blocks to give 64 blocks and by using the logistic map to increase the safety because it mixes the arrangement QR was used

After that, the analysis process begins. The R-matrix in the modulation algorithm using the new waveforms of the second level of the proposed algorithm gave the best results.

$$NC = \frac{\sum_x \sum_y W(x,y)W\prime(x,y)}{\sqrt{\sum_x W(x,y)}\sqrt{\sum_x W\prime(x,y)}} \quad (15)$$

In Table (3) the results of the proposed algorithm can be seen through the PSNR and NC values for all the watery images

Table3 Images of samples, watermark, watermark images and shows PSNR, NC watermark images without attacks

image	Gray image	Watermark W	Watermarked Image	PSNR1	NC
Image a				45.2366	1
Image b				44.9516	1
Image c				45.3642	1
Image d				46.3165	1

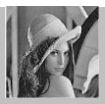
All procedures were tested on the watermark and the robustness of the algorithm was assessed in Table (4) and the effectiveness of the new wavelets DHWT in resisting attacks in Table (5)

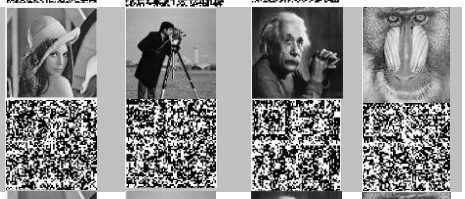
.

Table4 Results watermark images with attacks

	attacks	PSNR image1	NC image1	PSNR image2	NC image2	PSNR image3	NC image3	PSNR image4	NC image4
1	Salt and Pepper %1	27.098	0.9999	26.6076	0.9999	26.5350	0.9999	27.4456	0.9999
2	Salt and Pepper %5	22.6621	0.9999	22.3249	0.9999	22.0151	0.9999	22.9029	0.9999
3	JPEGCompression	59.0931	0.9999	59.0418	0.9999	58.8413	0.9999	58.5980	0.9999
4	Gaussian noise	37.6577	0.9999	37.6711	0.9999	37.6772	0.9999	37.6689	0.9999
5	Histequalization	19.0572	0.9988	19.0825	0.9988	11.9025	0.9988	16.4756	0.9988
6	Gaussianlowpassfilter	33.5516	0.9988	30.8466	0.9988	35.3597	0.9988	30.9082	0.9988
7	rotate	33.3455	0.9978	31.4071	0.9978	35.3597	0.9978	30.9082	0.9978
8	Poisson noise	27.1281	0.9900	26.9906	0.9900	29.4217	0.9900	27.0017	0.9900
9	Speckle noise	35.6501	0.9998	35.4975	0.9998	39.0531	0.9998	35.5068	0.9998
10	imadjust	22.1414	0.9999	19.3848	0.9999	24.8035	0.9999	19.3848	0.9999
11	motionfilter	25.6241	0.9999	23.3352	0.9999	26.1835	0.9999	23.3352	0.9999
12	averagefilter	33.5516	0.9999	30.9082	0.9999	35.3598	0.9999	30.9082	0.9999
13	medfilter	31.3918	0.9988	30.1354	0.9988	34.4199	0.9988	30.1335	0.9988
14	wiener	38.7865	0.9999	38.3668	0.9999	40.3362	0.9999	34.9624	0.9999
15	diskfilter	36.4474	0.9988	32.2760	0.9988	36.7007	0.9988	31.4071	0.9988
16	ordfilter	30.0709	0.9999	36.8095	0.9999	31.0382	0.9999	26.8095	0.9999

Table5: The effectiveness of the new wavelets DHWT in resisting attacks

	attacks	Image1	Image2	Image3	Image4
1	Salt and Pepper %1				
2	Salt and Pepper %5				
3	JPEGCompression				
4	Gaussian noise				
5	Histequalization				

		
6	Gaussianlowpassfilter	
7	rotate	
8	Poisson noise	
9	Speckle noise	
10	imadjust	
11	motionfilter	
12	averagefilter	
13	medfilter	
14	wiener	

15	diskfilter				
16	ordfilter				

As for the comparison in the results obtained in this work are that the NC=1 value obtained is better than that obtained in previous works.

4.CONCLUSION

The new wavelets Discrete Hermite wavelet Transform (DHWT) derived from Hermite polynomials were proposed to be illustrated in the analysis of the color image, after which the new algorithm was programmed, which mainly and effectively relies on the proposed wavelets, which is the response factor to secure the image because it bears the characteristics of the low filter and the high filter, while the algorithm was characterized by its efficiency and speed. The second factor on which the algorithm relies on the QR, which is the part LH 2×2 size, which proved the best location to include the proposed watermark image in this work, the final characteristic of the new algorithm. The image is under different attacks. The results tables show the efficiency and quality of the proposed new waveforms and the algorithm afterwards.

REFERENCES

[1] Z. Shao, Y. Duan, G. Coatrieux, J. Wu, J. Meng, and H. Shu, "Combining double random phase encoding for color image watermarking in quaternion gyrator domain," *Opt. Commun.*, vol. 343, pp. 56–65, 2015.

[2] P. P. Thulasidharan and M. S. Nair, "QR code based blind digital image watermarking with attack detection code," *AEU-International J. Electron. Commun.*, vol. 69, no. 7, pp. 1074–1084, 2015.

[3] Deb, K.; Al-Seraj, M.S.; Hoque, M.M.; and Sarkar, M.I.H. Combined DWT-DCT based digital image watermarking technique for copyright protection. Proceedings of the 7th International Conference on Electrical and Computer Engineering. Dhaka, Bangladesh, 4 pages 2012.

[4] Areej M. Abduldaim and Mohammed Qasim Hamid, " Robust image watermarking based on QR factorization and LWT", International Journal of Engineering & Technology**,** vol.7, no.4, pp.5358-5362, 2019.

[5] Nidaa F. Hassan, Akbas E. Ali, Teaba . Aldeen, Ayad Al-Adhami, Video mosaic watermarking using plasma key, Indonesian Journal of Electrical Engineering and Computer Science Vol. 22, No. 2, pp. 619-628, May 2021.

[6] R. Ahuja and S. Bedi, "Video Watermarking Scheme based on Candidates I-Frames for Copyright Protection," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 5, no. 2, pp. 391-400, Feb 2017, doi: 10.11591/ijeecs.v5.i2.pp391-400.

[7] X. Yu *et al.*, "A Survey on Robust Video Watermarking Algorithms for Copyright Protection," *Applied Sciences*, Oct 2018, doi: 10.3390/app8101891.

[8] R. KUMAR S. DILIPand K. SHAW, A Secured and Roboust Image Watermarking Based on Pixel Permutation Wavelet Transform and Singular Value Decomposition, Journal of Engineering Science and Technology Vol. 14, No. 4 (2019) 1924 – 1939

[9] Divya Audichya1, Dr. Vikas Soni, A Review on Colour Image Watermarking based on Wavelet and QR Decomposition, International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 12 | Dec 2019, 2526-2534.

[10] C. Li et al., "A Semi-Fragile Video Watermarking Algorithm Based on H.264/AVC," Mobile Intelligence Assisted by Data Analytics and Cognitive Computing 2020, 2020, doi: 10.1155/2020/8848553.

[11] C. Wang *et al.*, "Anti-HEVC Recompression Video Watermarking Algorithm Based on the All Phase Biorthogonal Transform and SVD," *IETE Technical Review (Online) Journal*, vol. 35, no. S1, pp. 42-58, doi:10.1080/02564602.2018.1477631.

[12] S. Almuzairai and N. Innab, "Video Watermarking System for Copyright Protection based on Moving Parts and Silence Deletion," International Journal of Advanced Computer Science and Applications (IJACSA), vol. 10, no. 2, 2019, doi: 10.1109/ICPCSI.2017.8391961.

[13] Kamred U.Singh, Color Image Watermarking Scheme Based on QR Factorization and DWT with Compatibility Analysis on Different Wavelet Filters, Jour of Adv Research in Dynamical & Control Systems, Vol. 10, 06-Special Issue, 2018, 1796-1811.

[14] T. Dutta and H. Gupta, "A robust watermarking framework for high efficiency video coding (HEVC)- encoded video with blind extraction process," *Journal of* Visual Communication and Image Representation, vol. 38, pp. 29-44, July 2016, doi: 10.1016/j.jvcir.2015.12.007.

[15] H.H. Khairi, Sharifah H. S. Ariffin, N. M. Abdul Latiff, Kamaludin Mohamad Yusof, M. K. Hassan, Mohammad Rava, The impact of firewall on TCP and UDP throughput in an openflow software defined network, Indonesian Journal of Electrical Engineering and Computer Science Vol. 20, No. 1, pp. 256-263, October 2020.

[16] Hawraa Abbas Almurieb, Eman S. Bhaya, Best neural simultaneous approximation, Indonesian Journal of Electrical Engineering and Computer Science, Vol. 20, No. 3, pp. 1584-1590, December 2020.

[17] Ban Bakhtyar Mahmud Shawkat, Asaad M. Jassim Al-Hindawi, Akram Hatam Shadir, Spectrum handoff analysis for multiple secondary users in cognitive radio networks, Indonesian Journal of Electrical Engineering and Computer Science Vol. 20, No. 1, pp. 264-274, October 2020.

[18] Prabira Kumar Sethy1, Nalini Kanta Barpanda2, Amiya Kumar Rath3, Santi Kumari Behera4, Rice false smut detection based on faster R-CNN, Indonesian Journal of Electrical Engineering and Computer Science Vol. 19, No. 3, pp. 1590-1595, September 2020.

[19] F. Layth Malallah et al., "Reversible color video watermarking scheme based on hybrid of integer-to-integer wavelet transform and Arnold transform," International Journal of Electrical and Computer Engineering (IJECE), vol. 10, no. 4, pp. 3519-3527, August 2020, doi: 10.11591/ijece.v10i4.pp3519-3527.

[20] Thajeel. S.A, Kadhim. L.M and Abdlateef. S.A " A new color im-age watermarking technique using multiple decompositions,", Journal Of Theoretical And Applied Information Technology, Vol.95, No.10, (2017), pp.2323-2331, available online: http://www.jatit.org/volumes/Vol95No10/24Vol95No10.pdf.

[21]] Su. Q, Wang. G, Zhang. X, Lv. G and Chen. B," A new algorithm of blind color image watermarking based on LU decomposition", *Multidim Syst Sign Process*, Vol.29, No.3, (2018), pp.1055-1047.

[22] M Saiful Islam, An imperceptible & robust digital image watermarking scheme based on DWT, entropy and neural network, karbala international journal modern science Volume 5 Issue 1 2019, 37-44.

[23] H.H. Khairi, Sharifah H. S. Ariffin, N. M. Abdul Latiff, Kamaludin Mohamad Yusof, M. K. Hassan, Mohammad Rava, The impact of firewall on TCP and UDP throughput in an openflow software defined network, Indonesian Journal of Electrical Engineering and Computer Science Vol. 20, No. 1, pp. 256-263, October 2020.

[24] T. S. Arulananth, M. Baskar, and R. Sateesh. "Human face detection and recognition using contour generation and matching algorithm." Indonesian Journal of Electrical Engineering and Computer Science, vol. 16, no. 2,
pp. 709–714, 2019.

[25] Shatha A. Salman, Abeer H. Abd-Almeer, Clotting detection in the vascular network, Indonesian

Journal of Electrical Engineering and Computer Science Vol. 20, No. 2, pp. 1103-1108, November 2020.

[26] F. Alkhalid, "The effect of optimizers in fingerprint classification model utilizing deep learning," Indonesian Journal of Electrical Engineering and Computer Science Vol. 20, No. 2, pp.1098-1102, November , 2020.

[27] H. Mohamed, and K. Wang. "Parallel score fusion of ECG and fingerprint for human authentication based on convolution neural network," *Computers & Security*, vol. 81, pp. 107-122, 2019.

[28] M. Rasheed, A.Abdulelah, S. Shihab, " The Effect of Set Partitioning in Hierarchical Trees with Wavelet De-composition Levels Algorithm for Image Compression," Electronics Science Technology and Application Volume 7 pp.40-46, 2020 .

[29] A. A. Abdulrahman, "Filters of Discrete Laguerrer wavelet Transformation in image processing," International Journal of Research and Analytical Reviews, 6 (2), 728-744, 2019.

[30] A. A. Abdulrahman, M. S. Rasheed and S. N. Shihab, "Discrete Hermite wavelet filter with prove mathematical aspects," Journal of Southwest Jiaotong University, 55 (2), pp.1-12, 2020.

[31] A. M. Hadia and A. A. Abdulrahman, "Image compression based with multi discrete Laguerre wavelets transform," Journal of Southwest Jiaotong University, 55, (2), pp.1-17, 2020.

[32] F. Shaker , A. Abdulelah," Face Detection By some Methods based on MATLAB, "Journal of Al-Qadisiyah for Computer Science and Mathematics Vol.12(4) , PP. 12–17, 2020.

[33] F. Shaker , A. Abdulelah," Hiding information by using Discrete Laguerre Wavelet Transform with new algorithms," Journal of the College of Basic Education, Vol.26(109) , PP. 447–458, 2020.

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