Tikrit Journal of Engineering Sciences (2025); 32(3): 2057
DOI: http://doi.org/10.25130/tjes.32.3.4

IRAQI Academic Scientific Journals

ISSN: 1813-162X (Print); 2312-7589 (Online)
Tikrit Journal of Engineering Sciences
available online at: http://www.tj-es.com

TJES
Tikrit Journal of Engineering Sciences

Image Compression-Based Discrete Wavelet Transform Combined with Zooming-out Algorithm

Hiba Muhammed Atta [a]*, **Mohammed Mustafa Siddeq** [b]
a Electrical Department, Engineering College, Tikrit University, Tikrit, Iraq.
b Computer Engineering Department, Technical College of Kirkuk, Northern Technical University, Kirkuk, Iraq.

Keywords:
Compression ratio; DWT; Image processing; Image compression; Image zooming; JPEG; JPEG2000.

Highlights:

- *Discarding high-frequency coefficients effectively reduced the image size without compromising quality.*
- *Reducing the high-frequency data using the Minimize-Final-Data technique compressed data represented as a stream of bits.*
- *Utilizing the discrete wavelet transform (DWT) to extract low-frequency coefficients represented essential information from the original image.*

ARTICLE INFO

Article history:

Received	10 Mar.	2024
Received in revised form	05 June	2024
Accepted	11 July	2024
Final Proofreading	06 Nov.	2024
Available online	17 June	2025

Citation: Atta HM, Siddeq MM. **Image Compression-Based Discrete Wavelet Transform Combined with Zooming-out Algorithm**. *Tikrit Journal of Engineering Sciences* 2025; **32**(3): 2057.
http://doi.org/10.25130/tjes.32.3.4

Corresponding author:

Hiba Muhammed Atta

Electrical Department, Engineering College, Tikrit University, Tikrit, Iraq.

Abstract: Image compression is one of the most important processes in image processing. It has numerous applications and plays a significant role in increasing transmission efficiency by reducing image size to just a few bytes, enabling the transmission of images without compromising their quality. The present study's proposed method focuses on reducing the size of an image through a compression technique. This technique involves extracting the essential information from the original image, which is represented by the low-frequency coefficients obtained through the discrete wavelet transform (DWT). By discarding the high-frequency coefficients, it can effectively preserve only the important details while significantly reducing the image size. In our approach, we employ the bi-cubic zoom-out method to resize the low-frequency coefficients, resulting in a high compression ratio. Finally, these high-frequency data are reduced by the Minimize-Final-Data method to produce compressed data (a stream of bits). Importantly, this zoomed-out image does not affect the overall image quality. We compared this proposed algorithm with both JPEG and JPEG2000 based on image quality and compression ratio. When applied to the Lena image, the proposed method achieved a PSNR of 40 dB and a compression size of 13.8 KB. However, when compared to the JPEG2000 method, the PSNR increased to 41.1 dB while maintaining a smaller compression size of 13.3 KB.

تحويل المويجات المنفصلة المعتمد على ضغط الصور مع خوارزمية التكبير

هبة محمد عطا[1]، محمد مصطفى صديق[2]
[1] قسم الكهرباء/ كلية الهندسة/ جامعة تكريت/ تكريت – العراق.
[2] قسم هندسة الحاسوب/ الكلية التقنية في كركوك/ الجامعة التقنية الشمالية/ كركوك – العراق.

الخلاصة
يعد ضغط الصور أحد أهم العمليات في معالجة الصور. وله العديد من التطبيقات ويلعب دورًا مهمًا في زيادة كفاءة النقل عن طريق تقليل حجم الصورة إلى بضعة بايتات فقط، مما يتيح نقل الصور دون المساس بجودتها. في هذه الدراسة، تركز الطريقة المقترحة على تقليل حجم الصورة من خلال تقنية الضغط. تتضمن هذه التقنية استخراج المعلومات الأساسية من الصورة الأصلية، والتي يتم تمثيلها بمعاملات التردد المنخفض التي يتم الحصول عليها من خلال تحويل المويجات المنفصلة (DWT). ومن خلال التخلص من معاملات التردد العالي، يمكننا الحفاظ بشكل فعال فقط على التفاصيل المهمة مع تقليل حجم الصورة بشكل كبير. في نهجنا، نستخدم طريقة التصغير ثنائية المكعب لتغيير حجم معاملات التردد المنخفض، مما يؤدي إلى نسبة ضغط عالية. أخيرًا، يتم تقليل هذه البيانات عالية التردد عن طريق تصغير البيانات النهائية لإنتاج بيانات مضغوطة (تدفق البتات). والأهم من ذلك أن هذه الصورة المصغرة لا تؤثر على جودة الصورة الإجمالية. قمنا بمقارنة هذه الخوارزمية المقترحة مع كل من JPEG وJPEG2000 بناءً على جودة الصورة ونسبة الضغط. تحقق الطريقة المقترحة نسبة PSNR تبلغ ٤٠ ديسيبل وحجم ضغط يبلغ ١٣٫٨ كيلو بايت عند تطبيقها على صورة لينا. ومع ذلك، عند مقارنتها بطريقة JPEG2000، يزيد معدل PSNR إلى ٤١٫١ ديسيبل مع الحفاظ على حجم ضغط أصغر يبلغ ١٣٫٣ كيلو بايت.

الكلمات الدالة: نسبة الضغط، معالجة الصور، ضغط الصور، تصغير الصور.

1.INTRODUCTION

An image is a combination of numbers represented by a very large group of rows and columns, which occupy a significant amount of space and make it difficult to transport. As a result, it is necessary to reduce the space occupied by these large numbers, which requires the use of various mathematical equations and the incorporation of new techniques that enhance image compression using advanced mathematical technologies [1]. Visual data compression has become crucial for quick data transport and effective media storage. While color images require 24 bits (three channels), grayscale images only need 8 bits per pixel. Additionally, the size of uncompressed images requires high bandwidth and low transfer rates. Therefore, the compression process is crucial when working with various media types. There are two types of image compression methods: lossless and lossy [2]. Image compression is essential for image transmission and storage. It makes it easier to store, transmit, and create images of appropriate size. It is also important to consider the data or signal itself, which may contain frequent transients and crucial information. The analysis of this data can be performed using the Fourier transform. As a result, the discrete wavelet transform (DWT) is the most widely used technique for image compression. In the discrete wavelet transform (DWT), the wavelets are sampled at discrete intervals. Wavelets are mathematical functions for decomposing images or other data [3]. The discrete wavelet transform (DWT) provides concurrent time-frequency and two-dimensional resolution (2D), making it more advantageous than the Fourier transform due to the DWT's ability to "zoom" in the time and frequency domains [3], [4]. In the present work, the bi-cubic zoom-out method is used to resize the low-frequency coefficients, significantly reducing file size and resulting in a high compression ratio. The high-frequency data is then further compressed using the Minimize-Final-Data approach, producing a compressed data stream in the form of bits.

2.RELATED WORK

Discrete Wavelet Transform (DWT) has been extensively studied and applied across various domains due to its efficacy in multi-resolution analysis. One significant area of related work is in image compression, where DWT has been employed to enhance compression efficiency while maintaining high image quality, as seen in standards like JPEG 2000 [5]. Researchers have also explored DWT in signal processing for noise reduction, leveraging its ability to separate signal components across different frequency bands. Moreover, DWT has been used in the field of digital watermarking. DWT has provided robust techniques for embedding compression watermarks in multimedia content, enhancing security and copyright protection. Recent advancements include combining DWT with machine learning algorithms to improve the accuracy and performance of various tasks, such as lossy image compression [6]. These diverse applications underscore the versatility and importance of DWT in modern computational and engineering problems. Some related works include:

- Image Compression Using Wavelet Transform by S. S. Agarwal and S. K. Singh: This work discussed DWT for image compression and compared different wavelet filters [7].
- A Survey of Image Compression Techniques Using Wavelet Transform by A. K. Jain and A. K. Verma. This survey paper provides an overview of different image compression techniques based on DWT and their performance evaluation [8].
- Image Compression Based on Wavelet Transform: A Review by M. S. Nair and S.

K. Nayar. This review article summarizes the advancements in image compression using DWT and highlights the key challenges and future research directions in this area [9].

The term "zoom-out images" typically refers to a technique used in computer vision and image processing where an image is analyzed at multiple scales or resolutions [1]. This method can be particularly useful in object detection, scene understanding, and image segmentation tasks, as it allows models to capture fine details and broader contextual information [5]. Here is an overview of related work and research areas involving zoom-out images:

- **Foveal Vision:** Inspired by human vision, foveal vision involves focusing on high-resolution details in a central region (zoom-in) while retaining lower-resolution information in the periphery (zoom-out). This approach is used in various computer vision tasks to balance detail and context [8].
- **Pyramid Representations:** Image pyramids are a common technique in which images are repeatedly down-sampled to create a series of images at different resolutions, allowing algorithms to process information at multiple scales [9].
- **Gaussian Pyramid:** An image pyramid where each level is a smoothed and down-sampled version of the previous one. A more complex representation that captures the differences between consecutive levels of a Gaussian pyramid is useful for image compression and texture analysis [10].

3.PROPOSED COMPRESSION ALGORITHM

In general, an image compression system consists of four essential stages: transformation (DWT), zoom-out (using the Bi-Cubic method), quantization, and arithmetic coding. Figure 1 illustrates the encoding process, while the decoding process is simply the inverse of the a forementioned stages.

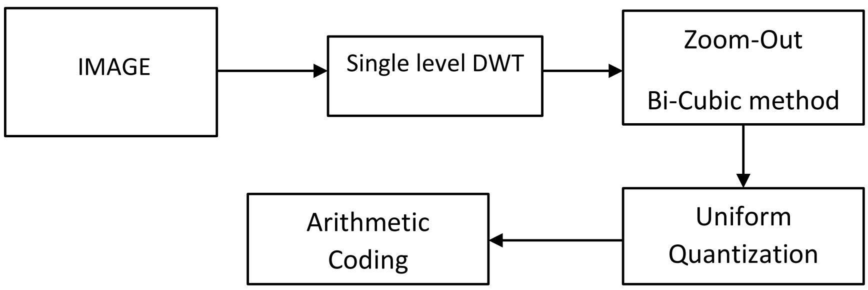


Fig. 1 Layout Proposed Image Compression.

Data resizing, whether upscaling or downscaling to adjust the resolution, is an important signal processing technique due to the diverse range of data sources. Data resizing is achieved through various interpolation methods, with replication, bilinear, and bi-cubic being the most common choices. These interpolation techniques are frequently implemented in commercial digital image processing software [5].

4.THEORETICAL BACKGROUND

4.1.The Discrete Wavelet Transform (DWT)

Recent image compression techniques, particularly those that execute at low bit rates, are crucial for applications including data streaming over the Internet, wireless communication, and storage on low-memory devices. The research has shown that wavelet-based image compression techniques can improve image quality at higher compression levels. DWT is a method of decomposing input signals into multiple resolutions. To separate signals into their low-frequency and high-frequency components, low-pass and high-pass filters are used, respectively. The forward decomposition of a signal is implemented for conventional DWT by a low-pass digital filter and a high-pass digital filter. The scaling function and associated wavelets are used to construct both digital filters [3]. The signal is periodically downscaled by the compression system using a set of filters that only allow half of the frequency range to get through [6]. The LL sub-band is subject to a Zoom-out algorithm (bi-cubic method) to make the LL matrix smaller and compressible. The quantization process in the system is based on dividing each sub-band of the signal by a constant value [7]:

$$LL_Q = round\left[\frac{LL}{Q}\right] \quad (1)$$

The quantization value Q strictly depend on the data, where $0 < Q \leq Max$. The maximum value of Q, denoted as Max, is the maximum value in the lowest frequency sub-band (the LL sub-band), i.e., the single quantization value Q is applied by dividing all the coefficients by that value and then rounding to the nearest integer. The final quantized sub-band is denoted as HQ. Figure 2 shows single-level DWT decomposition.

16x16 double

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	155	155	155	155	156	154	151	149	150	151	154	155	156
2	155	155	155	155	155	154	151	149	150	152	155	156	157
3	154	154	154	154	153	152	151	151	150	151	155	157	156
4	152	152	152	152	151	151	152	152	150	151	155	157	156
5	151	151	151	151	151	152	154	154	151	152	155	156	155
6	151	151	151	152	153	154	155	154	153	153	155	156	155
7	154	154	154	155	156	156	155	154	155	155	155	155	155
8	156	156	156	156	157	156	154	154	157	157	155	155	156
9	157	157	157	157	156	155	154	155	159	159	156	155	156
10	157	157	157	157	156	156	155	156	159	159	156	155	156
11	156	156	156	156	157	157	158	158	157	156	155	154	155
12	156	156	155	156	157	158	159	159	157	156	156	156	155

(a) Sample of Data from Lena's Image 16x16 (Before Decomposition by DWT)

10x10 double

	1	2	3	4	5	6	7	8	9	10
1	307.4475	307.4475	307.4854	307.2793	304.4654	301.0135	303.0657	313.0837	311.2915	307.8353
2	309.9714	309.9714	309.8120	310.9345	308.3239	298.8274	302.6125	309.8261	313.8296	317.9820
3	310.2182	310.2077	310.1280	310.7504	307.4805	298.8931	303.2710	311.6162	313.3830	314.3484
4	304.3658	304.4313	304.5450	303.7886	302.7319	302.8765	302.6451	312.5915	310.7154	307.5696
5	302.9918	302.6150	302.3243	303.8998	308.2257	307.6994	306.1689	311.0688	308.4408	310.7594
6	311.6007	311.5332	311.3589	312.4210	310.8927	309.2991	313.2952	310.9607	309.1304	305.5507
7	313.8722	313.6650	313.8014	313.7413	311.2770	312.7837	315.8604	309.8793	312.2413	311.3848
8	310.4568	311.6423	310.9684	310.9919	315.0112	317.4820	313.8566	311.5340	310.2820	314.4527
9	310.4798	310.4549	309.9620	311.8593	314.7294	314.3751	313.8164	315.4522	312.2637	315.0991
10	312.5013	312.1226	311.6561	314.4488	317.4724	309.3559	311.7376	314.1586	309.9632	310.2330
11										

(b) After Decomposition by DWT LL sub-band Generated.

Fig. 2 DWT Applied to Sample of Data Matrix 16x16 to Generate LL sub-band.

4.2.Bi-Cubic Zoom-Out

Interpolation is currently the most commonly used method of image magnification. The experiment examined the subjective and objective image magnification performance of various interpolation algorithms guide the user in choosing an appropriate algorithm to achieve the best results for various applications. The fundamental idea behind image magnification is to increase the number of image pixels, converting a low-resolution image into a high-resolution one [8]. Bicubic interpolation produces smoother, less distorted images than linear interpolation, and it is the Algorithm utilized the most in image processing [9]. An extension of cubic interpolation is bi-cubic interpolation. Using Lagrange polynomials, cubic splines, or cubic convolution methods, bi-cubic interpolation can be achieved. When process speed is not a problem, bilinear interpolation is usually preferred to bi-cubic interpolation in image processing. Bi-Cubic interpolation is more subtle than Cubic Interpolation. If the functional value f and the derivatives fx, fy, and fxy are known at all four angles (0, 0), (1.0), (0.1), and (1, 1) of the unit's square, the model for the Bi-Cubic interpolation method can be shown as follows in Eq. (2) [10].

$$p(x,y) = \sum_{i=0}^{3}\sum_{j=0}^{3} a_{ij}\, x_i\, y_j \qquad \textbf{(2)}$$

The sixteen coefficients are determined from the sixteen equations in sixteen unknowns that can be written using the sixteen nearest neighbors of point (x,y). Generally, bicubic interpolation preserves fine detail better than its bilinear counterpart [11]. Figure 3 shows the LL sub-band matrix 10×10 (See Fig. 2) zoomed-out using the bi-cubic method.

5x5 double

	1	2	3	4	5
1	309.0253	309.2806	303.0961	306.7059	313.1837
2	306.8701	307.0340	303.0821	306.9163	312.4476
3	307.2369	307.5873	308.6597	310.1991	308.6508
4	312.4984	312.5301	314.2736	313.1606	311.7428
5	311.1492	312.3113	314.1731	313.1564	312.2188

(a) LL Sub-Band Zoomed-Out.

5x5 double

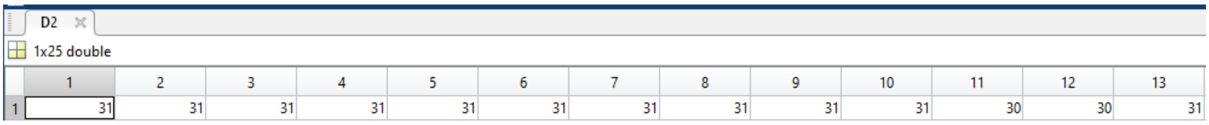
	1	2	3	4	5
1	31	31	30	31	31
2	31	31	30	31	31
3	31	31	31	31	31
4	31	31	31	31	31
5	31	31	31	31	31

(b) Final Zoomed-out Data Quantized (Divide Each Value by 10).

Fig. 3 Zoomed-Out Bi-Cubic Applied to LL Sub-Band.

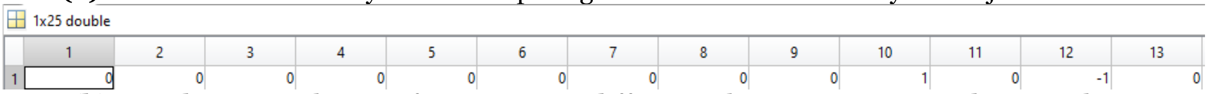
4.3.Minimize-Final-Data

Before the final step, the 5×5 matrix is converted into a one-dimensional array of 25 elements. Then, the differences between every two adjacent values are computed to increase the conversion of the matrix into high-frequency data, as shown in Fig. 4.



	1	2	3	4	5	6	7	8	9	10	11	12	13
1	31	31	31	31	31	31	31	31	31	31	30	30	31

(a) One-dimensional array before computing differences between every two adjacent values.



	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	0	0	0	0	0	0	0	0	1	0	-1	0

(b) One-dimensional array after computing differences between every two adjacent values.

Fig. 4 Matrix 5x5 Converted to One-Dimensional Array and Converted to High-Frequency Data.

In the Coding step, the final high-frequency data array is converted into a stream of bits. The algorithm examines each set of three adjacent data values and replaces them with a single value if they are the same. For example, if there is [3, 3, 3], the output is only 3. If the three adjacent values are not the same, the three data values are retained as they are. The coding steps are illustrated in Fig. 5.

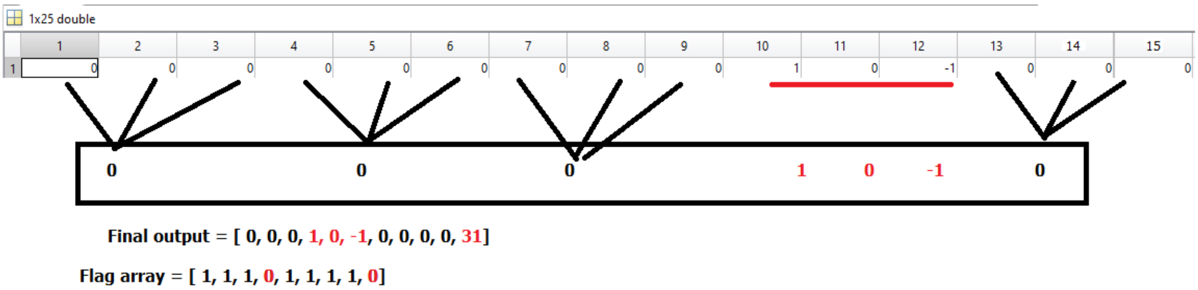


Fig. 5 Final Coding Steps Consist of (Final Output Array is Represented 88 bits), and Flag Array is 9 bits. The total Bits are 97 bits.

Note: The Flag array is used for decoding. In the above example, the 1st location has a value of "1." Then, the 1st location is checked in the Final output, which is "0," indicating that the original values were three zeros (0, 0, 0).

• If (Final array [L] == 1) THEN
Decode output = [Final output [L], Final output [L], Final output [L]]
L = L + 1; %% Check the next location in the Flag array to continue decoding
END {if}

Similarly, at the 4th location in the Flag array, a "0" is found. Then, the 4th location is checked in the Final output, which contains "1, 0, -1,"i.e., a zero is encountered in the Flag array, the output consists of the three adjacent values in the Final output.

• If (Final array [L]==0) THEN
Decode output= [Final output [L], Final output [L+1], Final output [L+2]]
L=L+3; %% Jump to next location in Flag array to continue decoding
END {if}

5.PROPOSED ALGORITHM RESULTS

The present work aims to elucidate the superiority of the proposed technique, demonstrated through MATLAB code. The code was executed on a laptop computer with an 11th Gen Intel(R) CoreTM i7-11800H processor running MATLAB R2021b. The operating system used was Windows 11 Pro. Common metrics used to evaluate image compression performance, including compression ratio (CR), peak signal-to-noise ratio (PSNR), root mean square error (RMSE), and structural similarity index (SSIMVAL), were used to compare the performance of the proposed compression method.

The suggested system is evaluated using eight grayscale images sourced from standard Bitmap BMP image files, covering different sizes commonly employed in image processing. The evaluation involves applying the discrete wavelet transformation and single-level decompression with a zoom-out ratio of 0.4 (60%). The proposed system is clearly illustrated in the following steps:

1- Read the original 2D image of size N×N.
2- Apply 2D DWT using the Daubechies filter level 3 (db3) wavelet over the image.
3- Apply the bi-cubic interpolation method (zoom-out).
4- Uniform Quantize LL sub-band to eliminate dispensable coefficients. While other sub-bands, i.e., HL, LH, and HH, are ignored and replaced with zeros instead of high-frequency coefficients.
5- The last step applies Minimize-Final-Data, which is used to reduce all high-frequency data redundancies by converting each set of three adjacent coefficients into a single data point. Then, all the data is converted into a stream of bits.
6- After decomposing the image, reconstruct an approximation to the original image by applying the inverse bi-

cubic method to reconstruct the approximate LL sub-band.

7- Apply inverse DWT to the LL sub-band to recompose an approximate version of the original image.

8- Measure the quality of the reconstructed images using error matrices (RMSE, PSNR, SSIMVAL).

Table 1 explains the compressed size and other parameters for one level. Figure 6 shows the decompressed images.

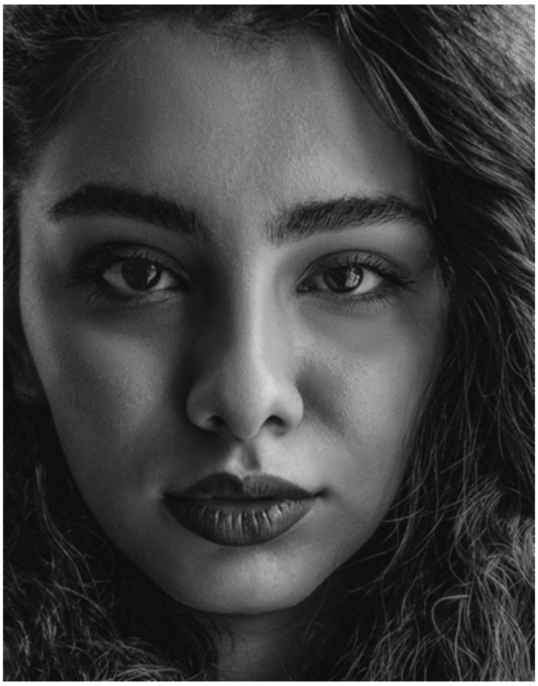
Table 1 Results of the Proposed Compression Method.

Image Name	Original Size	PSNR	RMSE	Compressed Size	Compression Performance	SSIM
Lena Image (1024 × 1024)	1 Mbytes	40.0	6.08	13.8 Kbytes	98.6 %	0.468
Omid_armin_Grey (2063×2623)	5.16 Mbytes	35.7	17.04	54.1 Kbytes	98.5 %	0.535
Michael-Am (1402 × 2123)	2.84 Mbytes	44.1	2.36	25.9 Kbytes	99.1 %	0.338
Man1(1600 × 1200)	1.83 Mbytes	39.7	6.81	24.1 Kbytes	98.7 %	0.536
Man2(3000 × 4499)	12.8 Mbytes	37.6	11.13	170 Kbytes	98.7 %	0.728
Eye (2048 × 1536)	3 Mbytes	43.7	2.71	31.4 Kbytes	98.9 %	0.528
Girl (1035 × 821)	831 Kbytes	43.1	3.02	11.3 Kbytes	98.6 %	0.635
Pattern (320 × 138)	44.1 Mbytes	36.5	14.52	0.551 Kbytes	98.7 %	0.661

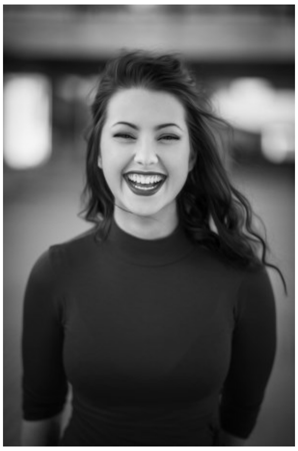
Original Lena Image
(size 1 Mbytes)

De-Compressed Image Proposed method
(Compressed size 13.8Kbytes)

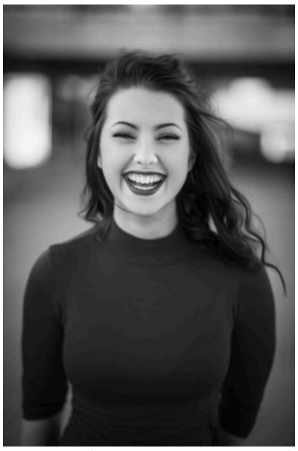
Original Omid_armin_Grey Image
(size 5.16 Mbytes)



De-Compressed Image Proposed method
(Compressed size 54.1 Kbytes)



Original Michael-Am Image
(size 2.84 Mbytes)



De-Compressed Image Proposed method
(Compressed size 25.9 Kbytes)

Original Man1 Image
(size 1.83 Mbytes)

De-Compressed Image Proposed method
(Compressed size 24.1 Kbytes)

Original Man2 Image
(size 12.8 Mbytes)

De-Compressed Image Proposed method
(Compressed size 170 Kbytes)

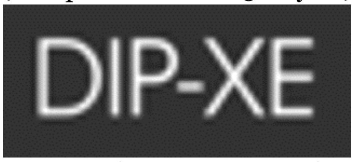
Original Eye Image
(size 3 Mbytes)

De-Compressed Image Proposed method
(Compressed size 31.4 Kbytes)

Original Girl Image
(size 831 Kbytes)

De-Compressed Image Proposed method
(Compressed size 11.3 Kbytes)

Original Pattern Image
(size 44.1 Mbytes)



De-Compressed Image Proposed method
(Compressed size 0.551 Kbytes)

Fig. 6 Image Results of the Proposed Method.

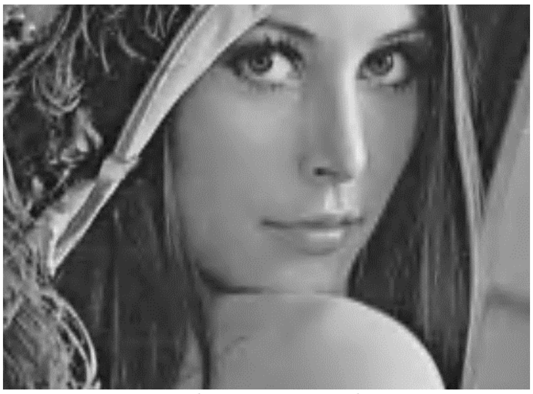
6.COMPARISON WITH THE JPEG2000 TECHNIQUE

The present approach is compared with JPEG2000, a technique widely used in digital image compression, particularly for image transmission and video compression. One disadvantage of this technique is that the decompressed image may contain blurring in some areas. The comparison is based on achieving a higher compression ratio while maintaining readable image quality, as illustrated in Table 2 and Fig. 7.

Table 2 Results of the Proposed Compression Method with JPEG2000.

Image Name	Original Size	PSNR	RMSE	Compressed Size	SSIM
Lena Image	1 Mbytes	41.1	5.03	13.3 Kbytes	0.613
Omid_armin_Grey	5.16 Mbytes	40.0	6.44	56.1 Kbytes	0.523
Michael-Am	2.84 Mbytes	44.8	2.01	25.3 Kbytes	0.470
Man1	1.83 Mbytes	42.1	3.95	22.5 Kbytes	0.655
Man2	12.8 Mbytes	45.4	1.87	170 Kbytes	0.703
Eye	3 Mbytes	45.4	1.86	29.5 Kbytes	0.581
Girl	831 Kbytes	43.7	2.77	11.2 Kbytes	0.694
Pattern2	44.1 Mbytes	41.2	4.88	0.840 Kbytes	0.864

De- Compressed Lena Image by Proposed method
(Compressed size 13.8 Kbytes)



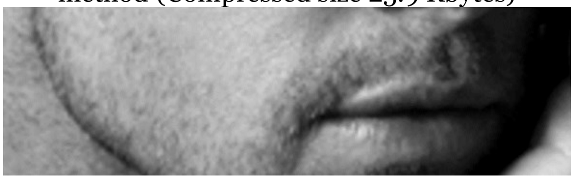
De-Compressed Lena Image by JPEG2000
(Compressed size 13.3 Kbytes)

De- Compressed Omid_armin_Grey Image by Proposed method (Compressed size 54.1 Kbytes)

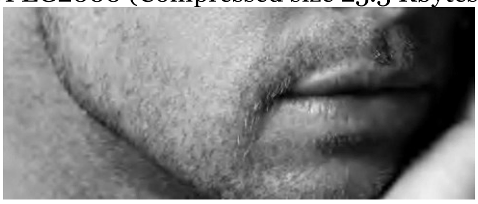
De-Compressed Omid_armin_Grey Image by JPEG2000 (Compressed size 56.1 Kbytes)

De-Compressed Michael-Am Image by Proposed method (Compressed size 25.9 Kbytes)

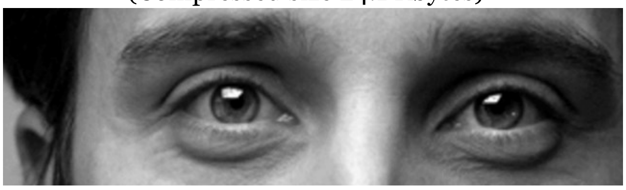
De-Compressed Michael-Am Image by JPEG2000 (Compressed size 25.3 Kbytes)



De-Compressed Man1 Image by Proposed method (Compressed size 24.1 Kbytes)

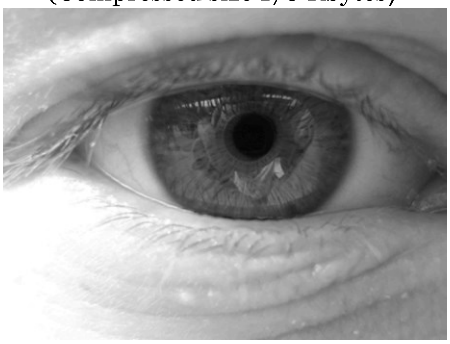


De-Compressed Man1 Image by JPEG2000 (Compressed size 25.5 Kbytes)

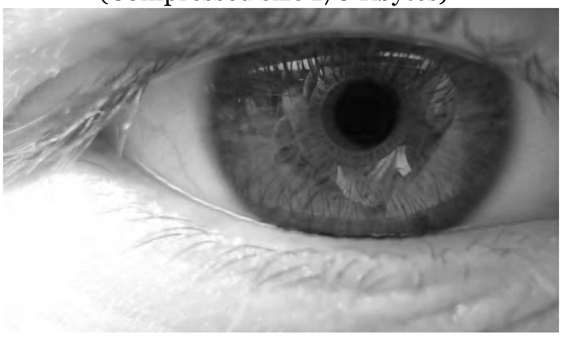


De-Compressed Man 2 Image by Proposed method (Compressed size 170 Kbytes)

De-Compressed Man 2Image by JPEG2000 (Compressed size 170 Kbytes)



De-Compressed Eye Image by Proposed method (Compressed size 31.4 Kbytes)

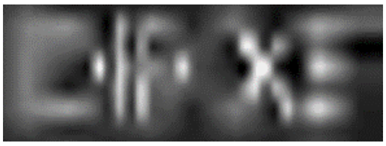


De-Compressed Eye Image by JPEG2000 (Compressed size 29.5 Kbytes)

De-Compressed Girl Image by Proposed method (Compressed size 11.3 Kbytes)

De-Compressed Girl Image by JPEG2000 (Compressed size 11.2 Kbytes)

De-Compressed Pattern Image by Proposed method
(Compressed size 0.551 Kbytes)



De-Compressed Pattern Image by JPEG2000
(Compressed size 0.840 Kbytes)

Fig. 7 Image Compared Between the Proposed Method with JPEG2000.

7.COMPARISON WITH THE JPEG TECHNIQUE

The JPEG technique is commonly used for digital image compression and is known for providing good visual quality with lower complexity. However, it struggles to maintain good visual quality at higher compression ratios, resulting in a noticeable degradation of image quality. This degradation includes reducing color levels, leading to a loss of realistic grayscale and producing unrealistic 2D images. A comparison between JPEG and the proposed compression technique can be seen in Table 3 and Fig. 8.

Table 3 Results of the Proposed Compression Method with JPEG.

Image Name	Original Size	PSNR	RMSE	Compressed Size	SSIM
Lena Image	1 Mbytes	38.8	8.49	18.2 Kbytes	0.507
Omid_armin_Grey	5.16 Mbytes	37.4	11.8	80.4 Kbytes	0.486
Michael-Am	2.84 Mbytes	41.3	4.80	39.4 Kbytes	0.609
Man1	1.83 Mbytes	40.1	6.32	28.6 Kbytes	0.461
Man2	12.8 Mbytes	40.2	6.08	171 Kbytes	0.561
Eye1	3 Mbytes	41.6	4.42	40.9 Kbytes	0.610
Girl	831 Kbytes	40.1	6.29	14.7 Kbytes	0.485
Pattern2	44.1 Mbytes	36.5	14.5	3 Kbytes	0.661

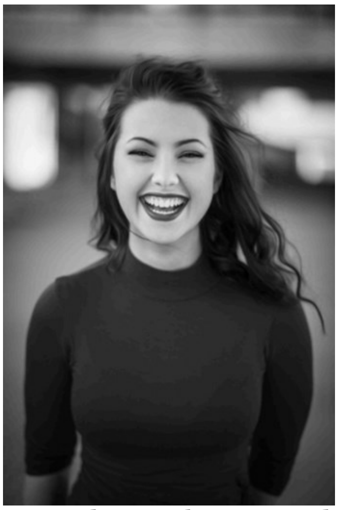
.

De- Compressed Image by Proposed method
(Compressed size 13.8 Kbytes)

De-Compressed Image by JPEG
(Compressed size 18.2 Kbytes)

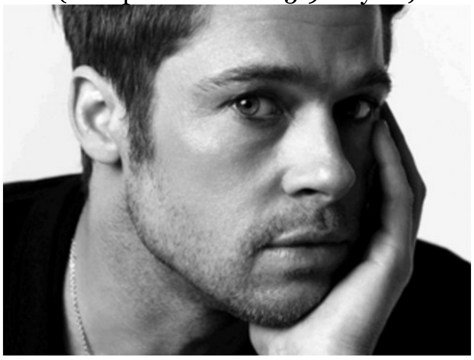
De- Compressed Image by Proposed method
(Compressed size 75.1 Kbytes)

De-Compressed Image by JPEG
(Compressed size 80.4 Kbytes)



De-Compressed Image by Proposed method
(Compressed size 25.9 Kbytes)

De-Compressed Image by JPEG
(Compressed size 39.4 Kbytes)

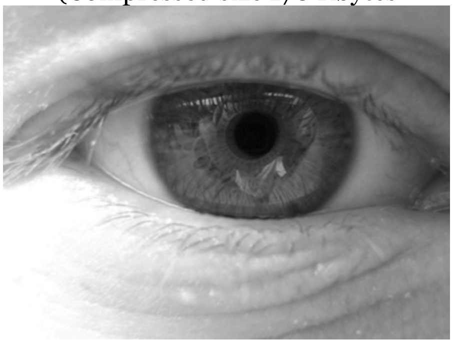


De-Compressed Image by Proposed method
(Compressed size 24.1 Kbytes)

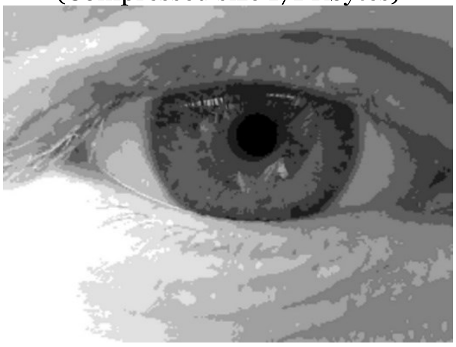
De-Compressed Image by JPEG
(Compressed size 28.6 Kbytes)

De-Compressed Image by Proposed method
(Compressed size 170 Kbytes

De-Compressed Image by JPEG
(Compressed size 171 Kbytes)



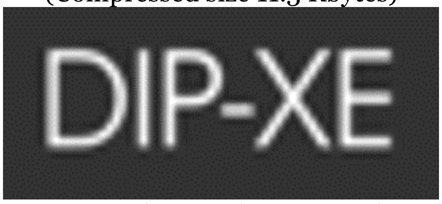
De-Compressed Image by Proposed method
(Compressed size 31.4 Kbytes)



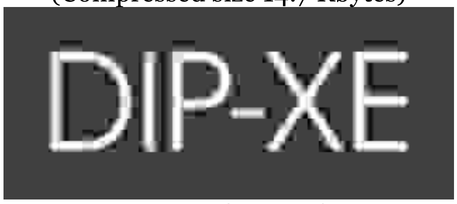
De-Compressed Image by JPEG
(Compressed size 40.9 Kbytes)

De-Compressed Image by Proposed method
(Compressed size 11.3 Kbytes)

De-Compressed Image by JPEG
(Compressed size 14.7 Kbytes)



De-Compressed Image by Proposed method
(Compressed size 0.551 Kbytes)



De-Compressed Image by JPEG
(Compressed size 3 Kbytes)

Fig. 8 Image Results of the Proposed Method with JPEG.

8.DISCUSSION AND CONCLUSIONS

A novel method for image compression has been demonstrated in the present paper that combines a single-level discrete wavelet transform with bi-cubic interpolation (image zooming-out), followed by a quantization process. The following steps illustrate the compression process used in our proposed method:

- The type of DWT used in the present paper is based on Daubechies discrete wavelet transformation, which yields a low-frequency domain subband (LL) and three other high-frequency subbands (LH, HL, and HH).
- The next step is to pass the LL subband through bi-cubic interpolation to zoom out the LL subband, followed by a uniform quantization process where all data are divided by a single value.
- Finally, the Minimize-Final-Data technique is used to reduce the high-frequency data and convert the final coded data into a stream of bits.

It is observed that the results of the suggested image compression algorithm are often very close to those of the JPEG2000 technique. Additionally, in certain situations, the suggested algorithms exhibit significantly better image quality than the JPEG2000 technique at higher compression ratios. Furthermore, the present proposed algorithm outperforms the JPEG technique. The comparison between methods is based on PSNR and RMSE, while SSIM is used to demonstrate the similarity between the original image and the decompressed image.

ACKNOWLEDGEMENTS

The Presidency of Tikrit University, College of Engineering, Electrical Engineering has sponsored this research project. The research was registered and documented at the National Center for the Protection of Copyright and Related Rights under the number M.W.T. 936 and the date 12-14-2023. The research was recorded in the department session #1 on 3-9-2023.

REFERENCES

[1] Yunis AA, Abdurrahman EH. **Comparison Among Some Image Zooming Methods.** *College of Basic Education Researchers Journal* 2013; **12**(3):761-774.

[2] Soudani RJ. **Supporting Zooming-in Process for Image Compression Based on High-Order Weighted 3D Polynomials Fitting.** *Iraqi Journal of Computers, Communications, Control & Systems Engineering (IJCCCE)* 2012; **16**(1):29-37.

[3] Siddeq MM. **JPEG and Sequential Search Algorithm Applied on Low-Frequency Sub-Band for Image Compression (JSS).** *Journal of Information and Computing Science* 2010; **5**(3):163-172.

[4] Zhao W, Zhao M, Pan J. **The Image Compression Technology Based on Wavelet Transform.** *Advanced Materials Research* 2015; **1078**:370-374.

[5] Sekar K, Duraisamy V, Remimol AM. **An Approach of Image Scaling Using DWT and Bicubic Interpolation.** *International Conference on Green Computing Communication and*

Electrical Engineering (ICGCCEE), Coimbatore, India, 2014; 1-5.

[6] Jeromel A, Žalik B. **An Efficient Lossy Cartoon Image Compression Method.** *Multimedia Tools and Applications* 2020; **79**(1):433-451.

[7] Hamoodat H, Alazzawi NM, Abduljabber RQ, Siddeq MM. **Image Compression Based on Frequency Domain Reduction Size.** *1st International Conference on Sustainable Development Techniques (ICSDT2022)*, Nineveh, Iraq, 2022; 1-7.

[8] Salih OM, Rostum HM, Vásárhelyi J, Siddeq MM. **Fast Joint Image Compression-Encryption Algorithm Used for 3D Reconstruction.** *24th IEEE International Carpathian Control Conference (ICCC)*, Szilvásvárad, Hungary, 2023; 400-405.

[9] Siddeq MM, Rasheed MH, Salih OM. **Quick Sequential Search Algorithm Used to Decode High-Frequency Matrices.** *Electrical and Computer Engineering* 2023; **17**(8):180-187.

[10] Abdullah D, Fajriana F, Maryana M, Rosnita L, Utama S, Andysah P, Rahim R, Harliana P, Harmayani H, Ginting Z, Erliana C, Irwansyah D, Zulmiardi Z, Khaddafi M, Milanie F, Aspan H, Huda I, Kundharu S, Mulyaningsih I. **Application of Interpolation Image by Using Bi-Cubic Algorithm.** *Journal of Physics: Conference Series* 2018; 012066.

[11] Jia Z, Huang Q. **Image Interpolation with Regional Gradient Estimation.** *Applied Sciences* 2022; **12**(15):1-15.