International Journal of Engineering Research and Advanced Technology (IJERAT)

E-ISSN : 2454-6135

DOI: 10.31695/IJERAT.2022.8.7.2

Volume.8, No. 7
July - 2022

Development of Hybrid Based Lossless Iris Image Compression Technique

Rasha Talib Gdeeb[1], Ghadah Al-Khafaji[2] & Noor Ali J[3]

[1]Department of Environmental Engineering

College of Engineering, University of Baghdad, Iraq

[2-3] Department of Computers, College of Science

University of Baghdad, Iraq

ABSTRACT

The biometric iris recognition is the most popular method and is extended successfully in use, but unfortunately a large number of data bits are exhausted when stored that implicitly affected the transmission bandwidth and compression solution urgently required that based on removing redundancy(s).

In this paper a simple hybrid image compression scheme is proposed, it is based on using two techniques of polynomial coding and Fourier transform coding to efficiently encoded lossless. The test results of the suggested method showed improved compression performance is achieved with identically base reconstruction image.

Key Words: Iris image compression, Zipper transform, Image processing, Polynomial coding, Hybrid coding.

1. INTRODUCTION

One of the most exact and acknowledged biometrics in the world, the iris recognition system for identity identification and verification, is gaining popularity [1]. The iris, which is the colored or hued component of the eye that surrounds the pupil, has distinct patterns that are visible under near-infrared illumination. These patterns are stable from a young age, barring trauma or sickness, allowing an exact ID number to be determined with a high degree of precision, allowing correct identification with a high level of confidence [1].

Enrollment in a commercial iris system necessitates the capture of one or more pictures from a video stream. Typically, the database for such a system does not contain actual iris images, but rather a binary file that represents each enrolled iris (the template), which necessitates a large number of bytes per eye (i.e., 307,200 bytes for a 640x480 grayscale image) [1], implying that data compression techniques be used to reduce the size of the image.

Image compression basically based on exploiting the Depending on the redundancy(s) type(s) utilized, redundancy within the picture itself, within the representation of image information, and within human perception (HVS)[2] may be divided into two categories: lossless and lossy. [3], or predictive and transform coding depending on domain utilized [3,4, 5, 6], where the mixed or combination these two ways, normally called hybrid coding.

Today, various accepted standard systems available that vary according to specific needs and requirements, for example JPEG, lossless JPEG, JPEG-LS, PNG, GIF, JPEG2000, and JPEG XR. These combine efficiency, simplicity, and speed with the capacity to meet a wide range of needs [2].

Currently, an efficient standard technique of JPEG based represents the cornerstone of all the biometric compressed images that based on transforming (mapping) the image into another equivalent domain (or frequency domain) through the utilization of linear transformation of DCT or DWT, where the decorrelation is possible, due to the capacity to express data using a limited number of coefficients.

Most researchers exploited JPEG and JPEG 2000 to compress biometric iris images , with various extended form of discrete wavelet transform (DWT) that implies the SPIHT and embedded zero-tree wavelet (EZW) coding techniques [7], along with curvelet transform in combination with lifting Wavelet [8], but with limitation of performance in terms of compression ratio and blocking artifacts of either lossless and lossy base respectively. However, the challenge and necessity of improving efficient biometric iris compression system performance grew, since this data is increasing day by day, which becomes an increasingly intensive and important research area to design and adopts modern techniques, Iris image methods are discussed in detail in [9-14].

One of the contemporary image compression approaches, polynomial coding, is still being developed and is being used by a number of companies. a number of researchers [15-20], based on modelling concept to efficiently reduce the spatial (interpixel) redundancy present in the image Polynomial coding's core concept is to use a mathematical model to represent each non-overlapping partitioning block with a minimal number of low-error coefficients (residual) [3].

In this paper, We provide a simple hybrid technique for reducing gray biometric iris image that is based on exploited the zipper transform which is adaptive form of discrete Fourier transform (DFT) of conjugate symmetry property and the promising polynomial coding of lossless base coding technique. The remainder of the article is arranged as follows: section 2 offers a thorough explanation of the proposed system; parts 3 and 4 contain the proposed system's outcomes and conclusions, respectively.

2. THE PROPOSED SYSTEM

The main concerns in the proposed system:

- Use spatial domain polynomial coding, which is made up of two parts: a mathematical function or model, also known as the deterministic part, which allows us to create an estimate image that looks like the original uncompressed image, and a residual or residue, also known as the probabilistic part, which allows us to find the modeling error between the original and estimated image. [3,6,20].
- By incorporating the transform coding techniques of *zipper* based on the resultant polynomial coding parts of coefficients and residual that leads to increase the efficiency of compression performance of lossless coding techniques.

The following stages are used to illustrate the proposed system (shown in Figure 1) and its implementation:

Step 1: Load the input. uncompressed iris grayscale image *I* of size $N \times N$.

Step 2: Apply polynomial coding techniques of linear base model that starts by determining the coefficients using the following sub steps, for more details see [3,17,18,20].

a) Divide the input image I into non-overlapping, fixed-size chunks. $n \times n$ (i.e., 4×4), to exploits the local similarity (local correlation).

b) Compute the linear approximation model's coefficients according to equations below[3,16,17,18] :

$$a_0 = \frac{1}{n \times n} \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} I(i, j) \text{.....(1)}$$

$$a_1 = \frac{\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} I(i, j) \times (j - x_c)}{\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (j - x_c)^2} \text{.......(2)}$$

$$a_2 = \frac{\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} I(i, j) \times (i - y_c)}{\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (i - y_c)^2} \text{......(3)}$$

Where the a0 coefficient is the mean (average) of the original image I's block of size (nxn). The a1 and a2 coefficients in I and j coordinates, respectively, denote the ratio of sum pixel multiplied by distance from the squared distance. The function variables (j-xc) and (i-yc) relate to well-known variables that measure the distance of pixel coordinates to the block center (*xc*, *yc*).

$$xc = yc = \frac{n-1}{2} \text{...................(4)}$$

Step 3: Use zipper transform to compress the computed polynomial coefficients, where the sub steps applied:

a) Apply the forward discrete Fourier transform (*DFT*) on each segmented block of fixed size (*nxn*) of non-overlapping nature, using equations (5-7), that corresponding to mapping into frequency domain of frequency based.

$$Fa_0(u,v) = \frac{1}{n \times n} \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} a_0(i, j) e^{-j_{comp} 2\Pi (ui+vj)/n} \text{.........(5)}$$

$$Fa_1(u,v) = \frac{1}{n \times n} \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} a_1(i, j) e^{-j_{comp} 2\Pi (ui+vj)/n} \text{..........(6)}$$

DOI : 10.31695/IJERAT.2022.8.7.2

$$Fa_2(u,v)=\frac{1}{n\times n}\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}a_2(i,j)e^{-j_{comp}2\Pi(ui+vj)/n}.......(7).$$

Where $a_0(i,j)$, $a_1(i,j)$ and $a_2(i,j)$ is the polynomial coefficient images of i, j are the spatial coordinates and u, v are coordinates in the transform domain. $Fa_0(u,v), Fa_1(u,v) and Fa_2(u,v)$ is the polynomial transform coefficients at position (u,v), where u, v, $i, j = 0,1,.....,n-1$, also the base of the natural logarithmic function e is about 2.71828; and j_{comp} the imaginary coordinate for a complex number, equals $\sqrt{-1}$.

b) Utilize the zipper transform (*ZT*) of interlace base to each Fourier transformed domain coefficients above ($Fa_0, Fa_1 and Fa_2$), where the imaginary parts of the complex The upper half of the symmetry's numbers are peeled away and interwoven with their true counterparts; for additional information, see [21].

c) Apply symbol encoding/decoding techniques to remove the coding redundancy embedded within the coefficients of transformed domain of Fourier base, using Huffman coding techniques.

d) Use the concatenating zipper transform (or simply inverse zipper transform) (*IZT*), in which In the top half of the symmetry, the imaginary bits of complex numbers are stripped away and concatenated with their real counterparts, see [21].

e) Reconstruct the compressed or decoded coefficients which is identical to the original ones of a_0,a_1 and a_2, from the encoded transformed coefficients, the decoder, simply use the inverse Fourier transform using equations below.

$$F^{-1}[Fa_0(u,v)]=a_0(i,j)=\frac{1}{n\times n}\sum_{u=0}^{n-1}\sum_{v=0}^{n-1}Fa_0(u,v)e^{j_{comp}2\pi(ui+vj)/n}................(8)$$

$$F^{-1}[Fa_1(u,v)]=a_1(i,j)=\frac{1}{n\times n}\sum_{u=0}^{n-1}\sum_{v=0}^{n-1}Fa_1(u,v)e^{j_{comp}2\pi(ui+vj)/n}................(9)$$

$$F^{-1}[Fa_2(u,v)]=a_2(i,j)=\frac{1}{n\times n}\sum_{u=0}^{n-1}\sum_{v=0}^{n-1}Fa_2(u,v)e^{j_{comp}2\pi(ui+vj)/n}................(10)$$

<u>**Step 4:**</u> Create the predicted image $\tilde{I}$ using the encoded polynomial coefficients resultant from step (3e) above, of each encoded block representation:

$$\tilde{I}=a_0+a_1(j-x_c)+a_2(i-y_c)......................(11)$$

<u>**Step 5:**</u> Find the residual or prediction error as the difference between the original *I* and the predicted one $\tilde{I}$.

$$\mathrm{Res}(i,j)=I(i,j)-\tilde{I}(i,j)..(12)$$

<u>**Step 6:**</u> Apply the zipper transform on the residual image (Res), that implies partition into fixed block of size *nxn*, followed by exploiting the discrete Fourier transform (DFT) and interlacing processes respectively.

$$F\,\mathrm{Res}(u,v)=\frac{1}{n\times n}\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}\mathrm{Res}\,e^{-j_{comp}2\Pi(ui+vj)/n}.........(13)$$

<u>**Step7:**</u> A traditional encoder/decoder applied on the residual transformed image of Fourier base using Huffman coding base, followed by concatenating and inverse discrete Fourier transform (IDFT), see(step 3, c,d, and e).

$$F^{-1}[F\,\mathrm{Res}(u,v)]=\mathrm{Res}(i,j)=\frac{1}{n\times n}\sum_{u=0}^{n-1}\sum_{v=0}^{n-1}F\,\mathrm{Res}(u,v)e^{j_{comp}2\pi(ui+vj)/n}................(14)$$

<u>**Step 8:**</u> Reconstruct or rebuild the compressed (decoded) image *I* of loss free base (identical to original one), simply by adds the estimated image to the residual one

$$I(i,j)=\tilde{I}(i,j)+\mathrm{Res}(i,j)\ ....\ (15)$$

3. EXPERIMENTAL RESULTS

In order to put the performance to the test, of the traditional techniques and comparing it with the proposed system, four standard gray (*256* gray levels or 8 bits/pixel) square (*256×256*) images of highly details are utilized as shown in figure (2), also the

DOI : 10.31695/IJERAT.2022.8.7.2

compression ratio adopted as criteria of lossless system base . The Compression ratio (ratio of original size to the compressed size in byte) adopted as an objective fidelity measure, as in equation (16). Figure (3) shows an example of decoded images.

$$CR = \frac{OriginalSize}{CompressedSize} \quad \text{................(16)}$$

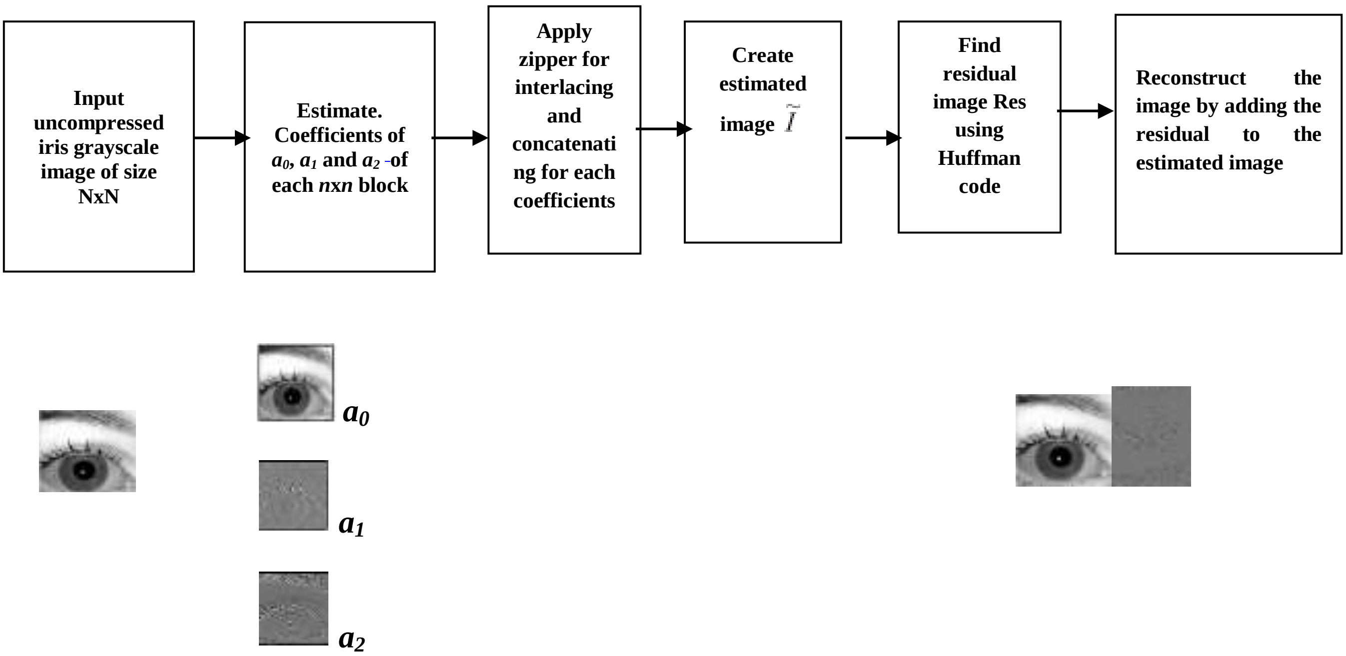
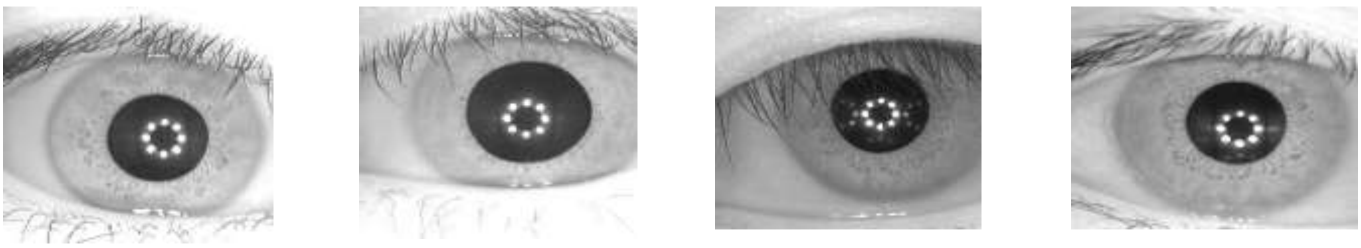


Fig. (1): The proposed system in a practical example.



(a) (b) (c) (d)

Fig. (2): The four Tested Images Of Size 256×256, Grayscale Images: (a) Iris1, (b) Iris2, (c) Iris2 and (d) Iris4.

The results shown in table (1) illustrate the comparison between the traditional techniques of Fourier transform, polynomial coding, and proposed techniques using block size of *4x4*. Obviously, the traditional techniques of spatial or transform coding characterized by the simplicity, but on the expense of efficiency in terms of low compression ratio.

Also, using the hybrid or mixed between the spatial and transformed domain When compared to the traditional, performance improved by approximately twice as much, namely by utilizing zipper coding base of interlacing and the concatenating of complex coefficients to the resultant polynomial coefficients and residual higher compression achieved. Fig.(3) demonstrates the

DOI : 10.31695/IJERAT.2022.8.7.2

performance of the traditional discrete Fourier transform, traditional polynomial and proposed system of Iris1, Iris2, Iris3 and Iris4 image using 4x4 block size.

Table (1): Comparison Performance Between Traditional Technique And Comparing it With The Proposed System Block Size of 4x4 of Tested Images

Tested Image	Traditional discrete Fourier transform	Traditional polynomial	Proposed system
	Cr	Cr	Cr
Iris1	4.6355	2.4820	7.1437
Iris2	4.2834	2.4492	6.6332
Iris3	4.5073	2.3533	6.9793
Iris4	4.2901	2.4643	6.6413

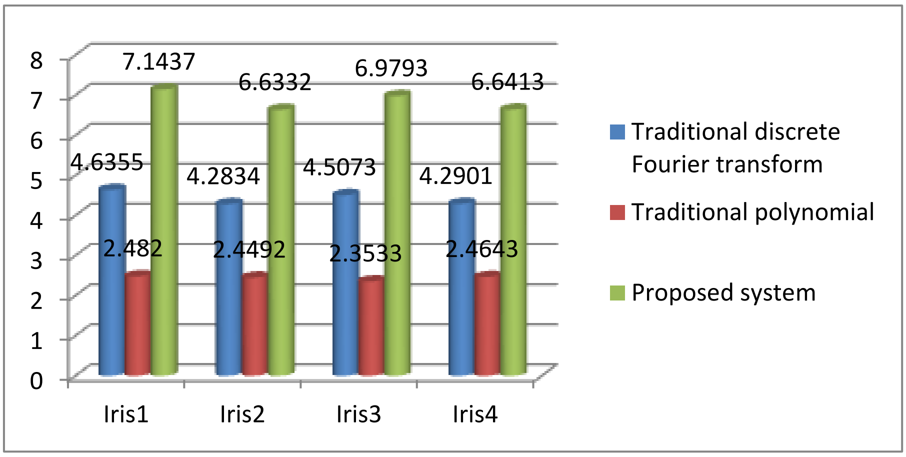


Fig. (3): The Performance Of The Traditional Discrete Fourier Transform, Traditional Polynomial and Proposed System of Iris1, Iris2, Iris3 and Iris4 Image using 4x4 Block Size.

4. CONCLUSION

This work proposes a simple hybrid image compression scheme. It is based on using two techniques of polynomial coding and Fourier transform coding to efficiently encoded lossless. The test results of the suggested method showed improved compression performance is achieved with identically base reconstruction image.

REFERENCE

[1] Gonzalez, R. C.and R. E. Woods, 2002.“Digital Image Processing”, 2nd edition, Prentice Hall, New Jersey.

[2]. Amruta, S.G. and Sanjay L.N, “A Review on Lossy to Lossless Image Coding”. International Journal of Computer Applications (IJCA),Vol. 67,No.17,pp. 9-16.,2013

[3] Rasha, T. 2015. ” Image Compression Using Enhancement Polynomial Prediction Coding”, M.Sc. Work, University of Baghdad.

[4] Marimuthu, M. and Swaminathan, P. Review Article:” An Overview of Image Compression Techniques”. Research Journal of Applied Science, Engineering and Technology, Vol .24,No.4,pp. 5381 -5386,2014

[5] Sachin, D.” A Review of Image Compression and Comparison of its Algorithms”. International Journal of Electronics & Communication Technology, Vol.2,No.1,pp22-26 , 2011.

[6] Khobragede, P. and Thakare, S. Image Comprssion Techniques-A Review International Journal of Computer Science and Information Technologies, Vol.5,No.1,pp. 272-275,2014

[7] Ghadah Al-Kafagi, Hazeem Al-K.,"Medical Image Compression usingWavelet Quadrants of Polynomial Prediction Coding & Bit Plane Slicing,"Medical Image Compression, vol.4, no.6,

DOI : 10.31695/IJERAT.2022.8.7.2

2014.
[8] Ghadah, Al-K. 2012. Intra and Inter Frame Compression for Video Streaming. Ph.D. thesis, Exeter University, UK.
[9] Noor, A. 2018. Experimental Study of Compression Techniques of Fourier Transform for Biometric Iris Data, Higher Diploma dissertation, University of Baghdad, College of Science.
[10] Shaymaa F., 2017. "The Use of Haar Wavelet and Polynomial Coding for Compressing Grayscale Image", Iraq: Higher diploma dissertation, Departement of Computer Science, University of Baghdad, Collage of Science.
[11] Babatunde S., 2015. "Development of an Improved Approach to Biometric Fingerprint Image Compression using Coiflet Signal Transformation Algorithm", Nigeria: Ph.D. thesis. Ahmed Bello University.
[12] GEORGE, L. E. AND GHADAH, AL-K. 2013. “Fast Lossless Compression of Medical Images based on Polynomial”. International Journal of Computer Applications, 70(15), 0975-8887.
[13] GEORGE, L. E. AND DHANNON, B. N. 2013.“Image Compression Using Polynomial and Quadtree Coding Techniques”.International Journal of Scientific & Engineering Research, 4(11), 2229-5518.
[14] GHADAH, AL-K. 2013. “Hybird Image Compression based on Polynomial and Block Truncation Coding”. Electrical Communication Computer, Power and Control Engineering (ICECCPCE), International Conference on Mosul, IEEE,179-184.
[15] ABDULLAH, A. 2018. Hierarchal Polynomial Coding for Grayscale Lossless Image Compression. Diploma dissertation, University of Baghdad, Collage of Science.
[16] BABAJIDE, O. 2017. A Fast and Efficient Near-Lossless Image Compression Using Zipper Transformation, Electrical and Computer Engineering University of Louisville, Louisville, KY 40218, 1 - 13.
[17] SANGEETHA, M., BETTY, P. AND NANDA, K. 2017. A Biometrie Iris Image Compression Using LZW and Hybrid LZW Coding Algorithm. International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), Coimbatore, India, IEEE Xplore.
[18] KHOBRAGEDE, P. AND THAKARE, S.2014. Image Comprssion Techniques-A Review International Journal of Computer Science and Information Technologies, 5(1), 272-275.
[19] BENS, P., AND INGRID, C. 2012. Comparative Evaluation on Iris Recognition Performance. International Journal Of Mathematical Models And Methods In Applied Sciences, 6(2), 332 - 339.
[20] JOHN, D. AND CATHRYN, D. 2008. Effect of Severe Image Compression on Iris Recognition Performance. IEEE Transactions On Information Forensics And Security, 3(1), 52 - 61.
[21] ROBERT, W., YINGZI, D. AND DANIEL, A. 2009. Effects of Image Compression on Iris Recognition Performance and Image Quality, Conference: Computational Intelligence in Biometrics: Theory, Algorithms, and Applications, IEEE Xplore, CIB.2009.4925681, 2-7.

*C. author email: rashatalib1@yahoo.com

DOI : 10.31695/IJERAT.2022.8.7.2