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Lossless Compression of Gray Scale Image by Discrete Wavelet Transform and Particle Swarm Optimization

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Abstract
The advancement of digital technology needs fast processing of data. the processing speed of data depends on the size, the big size of data required more space and bandwidth for the processing of data. the efficient process of image compression reduces the size of data and increase the speed of the processing of data. In this paper proposed efficient image compression algorithm based on discrete wavelet transform and particle swarm optimization. The discrete wavelet transforms used for the processing of data decomposition and particle swarm optimization used for the process of searching and scanning of decomposed block. The nature of particle swarm optimization is dual and diverse, so the processing of compression is fast instead of DWT and DCT transform function. The proposed algorithm gives the better PSNR and compression ratio of DWT and DCT transform function.

Keywords: Digital Image, Compression, Gray Scale, Transform Function, PSO, PSNR

Introduction

The increasing rate of digital data required more space for storage and more bandwidth for the transmission purpose. For the reduction of data storage space and more utilization of bandwidth required digital data compression technique. in the journey of image compression technique various algorithm and process are used in both domains spatial and frequency based technique. Now a day's various authors focus on frequency based image compression technique. The frequency based image compression technique used various transform function such as FFT, DCT and many more transform function. All these transform function gives better image compression technique in consideration of image quality value. But the factor of quality compromised with compression rate and compression ratio[1-3]. For the improvement of compression ratio and compression rate used neural network model and swarm intelligence technique. The combination of swarm intelligence and neural network model increase the compression speed of digital image data. The combination of neural network model and swarm intelligence give the new area of image compression[5]. The combined model focused in terms of redundant pixel of image and non-redundant pixel for image compression. In this dissertation proposed a parallel genetic algorithm along with fractal transform function for the processing of image compression. The proposed algorithm is also called extension of DWT compression technique. In the process of proposed work discuss the property and working principle of transform and particle swarm optimization[2, 6].

Data compression is a process of reducing the amount of data required to represent a given quantity of information. The data and information are not the same; data are the means by which information is expressed. Since various amounts of data can be used to represent the same amount of information, representations that are irrelevant or repeated information are said to contain redundant data [13]. Most 2D intensity arrays contain information that is ignored by the human visual system and/or irrelevant to the intended use of image. Data compression is one of the most used techniques in the field of image processing. JPEG was developed in 1992, using the DCT, it is simple and widely used technique for image compression, but results in blocking artifacts, ringing effects and false contouring appreciably for high compression ratio. Discrete Wavelet Transform (DWT) based coding, is another efficient technique used for image compression named as JPEG2K. The ability to display image at different resolutions like low frequencies and high frequencies simultaneously makes it a better method compared to others. Utilizing the benefits of both (DWT-DCT) popular coding techniques a new technique known as hybrid JPEG technique has been introduced where these two coding schemes are implemented together. A few efforts are devoted to such hybrid implementation in research area nowadays. A hybrid transformation scheme for video coding is presented, which minimizes prediction error [8-10].

II. Wavelet Transform

Wavelet transform function is useful transform function for lossless data encoding in image processing. The value of transform H(Z) is always whole number and the part of image is lossless. For lossless coding it is necessary to make an invertible mapping from an integer image input to an integer wavelet representation. The lifting scheme is used to construct symmetric bi-orthogonal wavelet transforms starting from interpolating Deslauriers–Dubuc scaling functions[12]. A family of (N, N) symmetric bi-orthogonal wavelets is derived, where N is the number of vanishing moments of the analysis high-pass filter and N is the number of vanishing moments of the synthesis high-pass filter. An instance of this family of transforms is the (4, 2) interpolating transform. The integer version of it, given in [7], is implemented in the first stage of our coding algorithm. In this case, the integer wavelet representation of a one-dimensional signal $A^0(n)$ having N nonzero samples is given by

$$\forall n: D^{i+1}(n) = A^i(2n+1) - [\sum_k pkA^i\big(2(n-k)\big) + 1/2]$$

$$0 \le i < j, 0 \le n < 2^{-(i+1)}N$$

$$-2 \le k \le 1$$

$$\forall n: A^{i+1}(2n) = A^i(2n) + [\textstyle\sum_k ukA^{i+1}(n-k) + 1/2] \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$0 \le i < j, 0 \le n < 2^{-(i+1)}N$$

$$0 \le k \le 1$$

where[x] represents the integer part of x,j is the number of scales,$A^{i+1}(n)$ and $D^{i+1}(n)$ denote, respectively, the Approximation and the detail of the original signal calculated at the scales (i+1), 0≤ I <j. The integer part of transform function gives the better encoding technique. The encoded transform value creates the number of packet and the randomly assigned packet in give dimension for search space.

III. POS (Particle of Swarm Optimization)

Particle Swarm Optimization (PSO) was proposed by Eberhart and Kennedy [12]. The PSO is a population based search algorithm based on the simulation of the social behavior of birds, bees or a school of fishes. PSO initially intends to graphically simulate the graceful and unpredictable choreography of a bird folk. Each individual within the swarm is represented by a vector in multidimensional search space. This vector has also one assigned vector which determines the next movement of the particle and is called the velocity vector[14]. The PSO also determines how to update the velocity of a particle. Each particle updates its velocity based on current velocity and the best position it has explored so far; and also based on the global best position explored by swarm. The PSO process then is iterated a fixed number of times or until a minimum error based on desired performance index is achieved. It has been shown that this simple model can deal with difficult optimization problems efficiently. The PSO was originally developed for real valued spaces but many problems are, however, defined for discrete valued spaces where the domain of the variables is finite[14].

ALGORITHM PROCEDURE

1. Initialize Population
2. Calculate fitness values of particles modify the best particles in the swarm Choose the best particle
3. Calculate the velocities of particles
4. Update the particle positions
5. until requirements are met

Particles are initialized by assigning random positions in the search space. Velocities are initialized randomly in the range $[\upsilon_{min}, \upsilon_{max}]$. In each iteration a new velocity is calculated for each particle and the new position is determined as the sum of the previous position and the new velocity.

$$x(t+1) = x(t) + \upsilon(t+1) \qquad (1)$$

While updating the new velocity, the best position of current particle achieved so far (p(t), particle best) and the best position achieved so far by all particles (g(t), global best) are used this:

$$\upsilon(t+1) = \omega\upsilon(t) + \varphi_1 \text{ Rad.}(0, 1)\,(p(t) - x(t)) + \varphi 2\text{Rad}(0, 1)(g(t) - x(t)) \qquad (2)$$

Where ω is inertia weight which controls the magnitude of the old velocity υ(t), φ_1 and φ_2 determine the significance of p(t) and g(t), respectively. Furthermore, υi at any time step of the algorithm is constrained by the parameter υ_{max}.

IV. Proposed Methods

In this section describe the proposed algorithm for image compression using wavelet transform and particle of swarm optimization technique. Basically, in this algorithm PSO are used for removal of redundant block of block in common similar block and create separate block and both block supply to HCC matrix and finally image is compressed. For the searching of redundant block and non-redundant block used fitness constrains function, those blocks satisfied the given constraints are called non-redundant block else redundant block.

1. input the Raw image

2. Apply 2D DWT transform function and decomposed the image into number of layer in terms of details and approximate.
3. The approximate part of transform is further exploded in high level.
4. compute the value of horizontal transform, vertical transform and diagonal transform value
5. The block coefficient value of transform forms a series of blocks p1…………Pn.
6. these block passes through PSO algorithm and find optimal set of blocks
7. group the similar block
8. and redundant block in different group
9. two block codes are generated one is redundant and another is non-redundant
10. the sorted block of redundant and non-redundant input the HCC matrix [13]
11. image compressed
12. find C.R value
13. find PSNR value
14. find Compression Rate.
15. Exit

PROPOSED MODEL

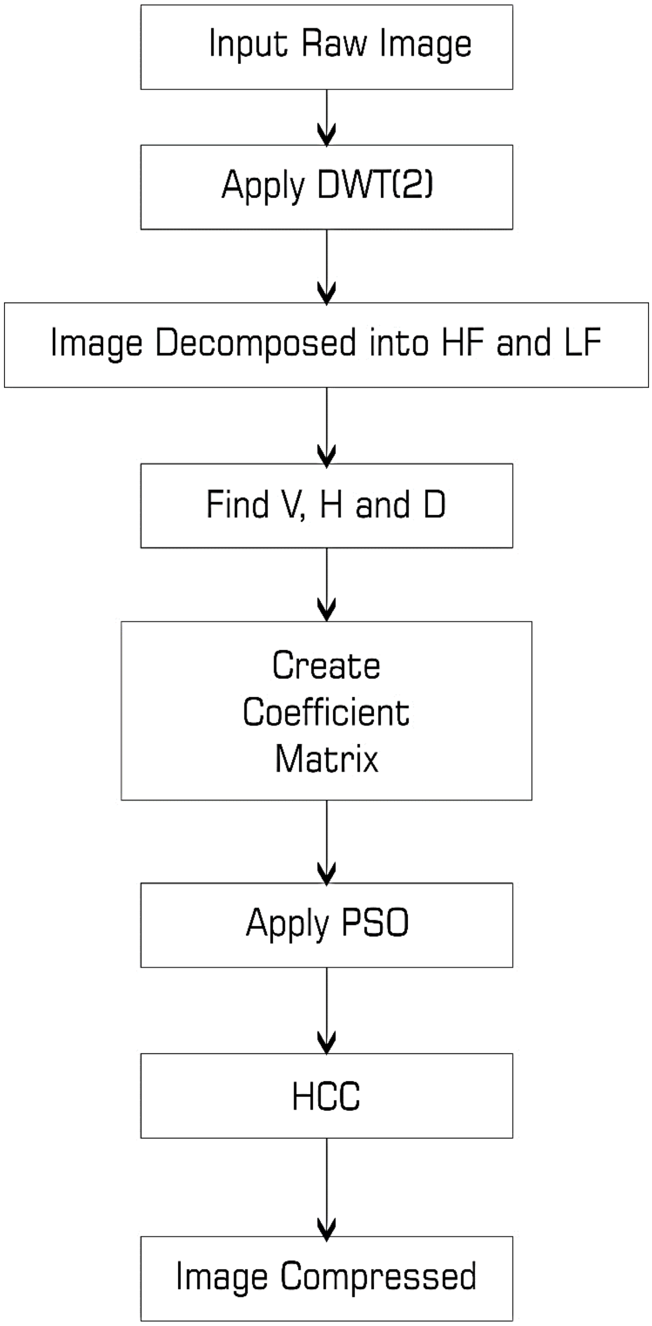

Figure 1: Proposed model of image compression

V. Simulation & Result Analysis

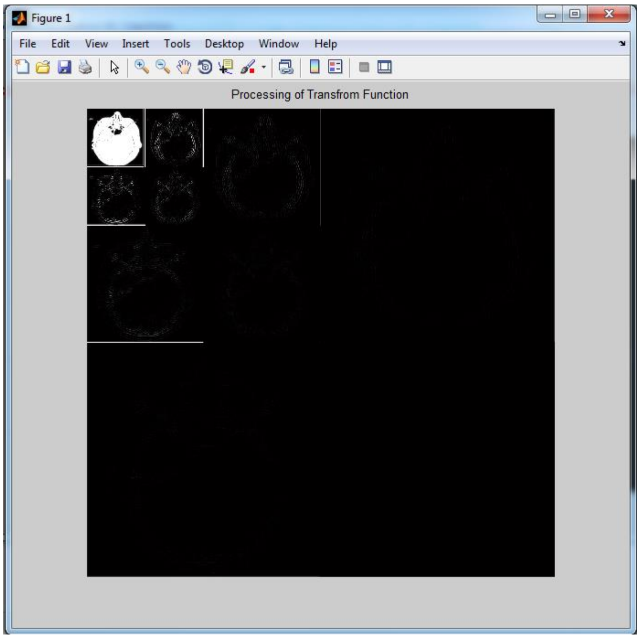

Figure 2: show that the processing window of implementation for BHCT1-image using DCT method.

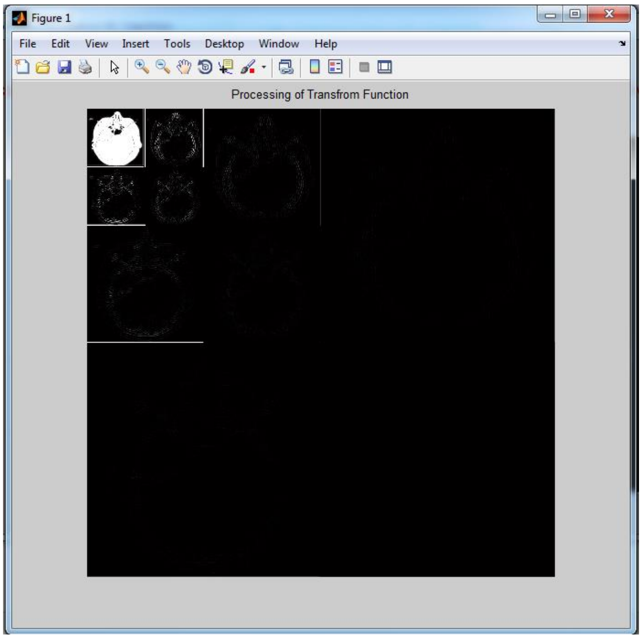

Figure 3: show that the compressed image window of implementation for BHCT1-image using DWT method.

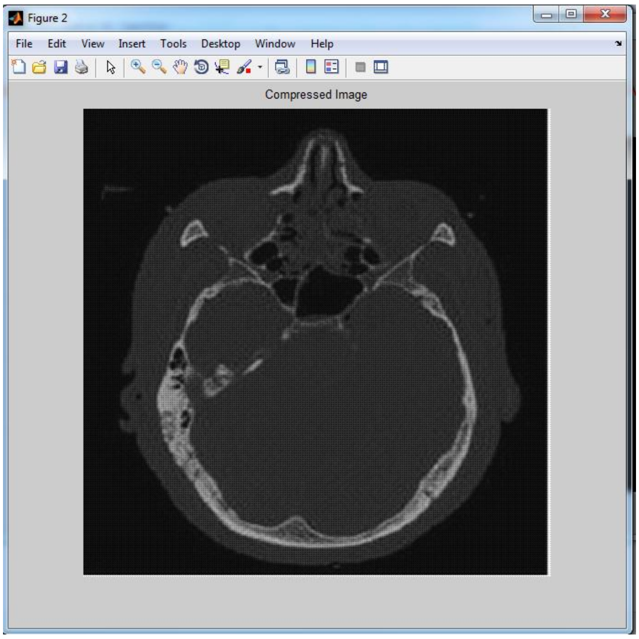

Figure 4: show that the processing window of implementation for BHCT1-image using Proposed method.

METHOD	Compression Ratio	Elapsed Time	PSNR
DCT	0.20402	2.764899	15.022122
DWT	1.504	2.230397	23.022122
PROPOSED	1.904	2.278958	25.022122

Table 1: Show that the Comparative values of Compression Ratio, Elapsed Time and PSNR for AHCT1 image using DCT, DWT and Proposed Method.

METHOD	Compression Ratio	Elapsed Time	PSNR
DCT	0.20674	2.627560	20.901528
DWT	1.5067	2.620161	28.901528
PROPOSED	1.9067	2.617354	30.901528

Table 2: Show that the Comparative values of Compression Ratio, Elapsed Time and PSNR for BHCT1 image using DCT, DWT and Proposed Method.

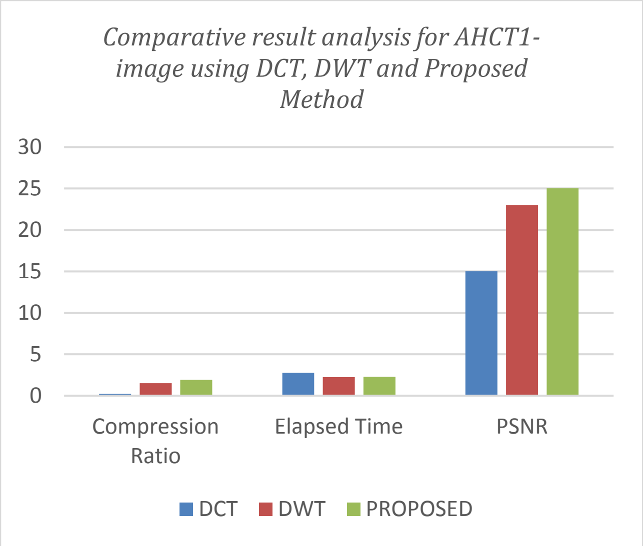

Figure 5: Shows that the comparative result graph for AHCT1-image using DCT, DWT and Proposed Methods, here we found the value of Compression Ratio, Elapsed Time and PSNR.

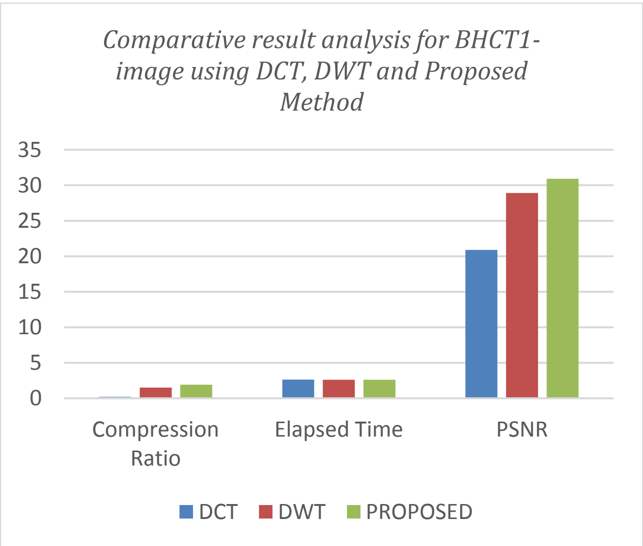

Figure 6: Shows that the comparative result graph for BHCT1-image using DCT, Hadamard and Proposed Methods, here we found the value of Compression Ratio, Elapsed Time and PSNR.

VI. Conclusion & Future Scope

In this paper modified the DWT image compression technique using particle swarm optimization algorithm. The modified image compression algorithm is very efficient in terms of compression ratio and compression rate. The proposed algorithm also retains the quality of image in terms of better PSNR value. The better PSNR value indicates that proposed algorithm is better than pervious algorithm such as DWT and DCT compression technique. The proposed algorithm gives the advantage of loosy image compression towards lossless image compression. The modified algorithm is combination of DWT and PSO algorithm. For the validation and empirical evaluation of proposed algorithm used MATLAB software and some standard image dataset. The increased value of PSNR and C.R value shows that our process is better. The proposed algorithm is better in terms of image quality in terms of PSNR value and some other parameter. The proposed algorithm compressed gray scale image and medical image. In future used color image compression process and enhanced the compression method.

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