Comparative analysis of image and video compression algorithms

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Abstract: With the constraint of transmission capacity and information rate for exchange, the need of great importance is the reducing the size of information. Particularly for pictures and recordings, the information devoured is exceptionally high and requires extremely huge capacity supports. the compression of information is one of the solution to confine size of information that is transmitted at once. The picture compression may be possible either without loss of information or with some acceptable loss in information. Lossy Image Compression Techniques have developed. Among them, some can be connected on the first picture to pack the information contained in it. In this paper the examination is made against different techniques like DWT-discrete wavelet transform, DCT-discrete cosine transform, hybrid methods and SA-DWT. The parameters measured for examination were the image compression ratio(ICR), peak signal to noise ratio(PSNR) and mean square error(MSE). The programs developed in MATLAB and were checked for various pictures. As the video is a changed over type of a succession of pictures converged as edges, a similar calculation can be connected to video compression.

Index Terms **- Image compression ratio (ICR), mean square error(MSE), peak signal to noise ratio(PSNR), DWT, DCT, SA-DWT, SA-DCT.**

1. INTRODUCTION

The modern era has the evolved technologies that transfer bulk data like images and videos [11][13]. Hence due to limitations in data rate of transfer and bandwidth, new techniques related to compression of images and videos have evolved [15]. Among them Lossy compression is proved to be a good choice as it avoids the large buffer sizes required for data storage and minimum length of data for transfer[5][6][7]. As the raw data transmission consumes larger bandwidth and it requires huge storage space; so, it is wanted to represent the information in the data by means of considerably fewer bits using data compression techniques [1][2][12]. At the same time, compression method must be able to rebuild the data very near to original data. This can be achieved through an effective and efficient compression and decompression algorithms [8][9][10]. The DWT and DCT are the mainly used algorithms [3][4][14]. The figure 1 shows the flow chart of the image compression process as performed in this paper.

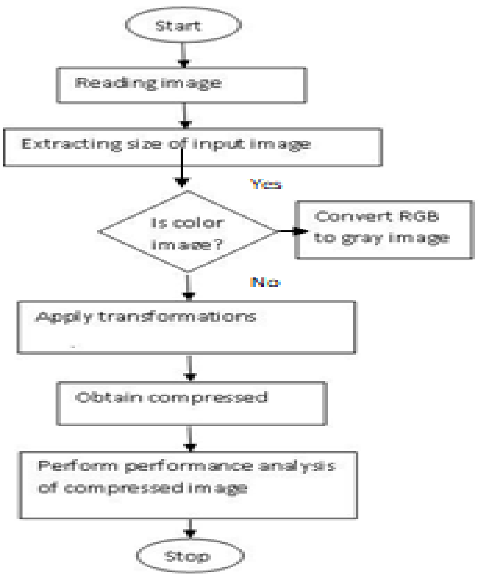

Figure 1.Flow Chart of Image Compression Process

This paper is organized as section II describes the DCT and DWT Transforms with their corresponding drawbacks. To overcome these, hybrid algorithms are introduced in section III, the advantages of Discrete Wavelet Transform (DWT) and Discrete cosine Transform DCT are added. Section IV describes the SA-DWT and corresponding simulation results and comparison are in. Section V and section VI concludes the paper followed by references.

2. DWT AND DCT ALGORITHMS

The property DCT is high quality compaction and requires less number of computational assets. The strength compaction property of a calculation suggest to the capacity to focus most essential data motion into as much as few low recurrence segment. The DWT is a multi-goals change and variable compression can be effectively accomplished. The DCT can be connected as a forward DCT or in reverse DCT.

The articulation for comparing the forward DCT is given by

$$X(m) = u(m)\sqrt{\frac{2}{N}}\sum_{i=0}^{N-1} x(i)\cos\frac{(2i+1)m\pi}{2N}, \text{ for } m = 0, 1, \ldots, N-1,$$

$$\text{where } u(m) = \begin{cases} 1 & \text{for } m = 0; \\ \frac{1}{\sqrt{2}} & \text{otherwise.} \end{cases} \quad ..(1)$$

The equitation for Backward DCT is given by

$$x(i) = \sqrt{\frac{2}{N}}\sum_{m=0}^{N-1} u(m)X(m)\cos\frac{(2i+1)m\pi}{2N} \quad .... (2)$$

A. *The DCT scheme calculation process*

- First the Matrix introduction is accomplished for the information picture.
- The quantized and standardized DCT compression is performed on the picture
- Zigzag coding of each 8x8 square is performed and
- Unused factors are cleared from memory space.
- Run length encoding of the subsequent picture is performed
- Run length unraveling of the compacted picture is performed
- Zigzag unraveling of the 8x8 squares is performed
- Denormalizing the Reconstructed Transform framework is performed.
- IDCT performed on the remade Matrix to get the Packed and DCT handled picture.

The fundamental thought of the WT is to speak to the flag to be investigated as a superposition of wavelets. The wavelet can be depicted by utilizing two capacities, the scaling work φ(t), known as 'father wavelet'. The wavelet work ψ(t) or 'mother wavelet'. Joining this acquires a girl wavelet. A group of wavelets can be produced by enlargement and deciphering the mother wavelet ψ(x). Figure 2 speaks to one stage in a multi scale pyramid deterioration of a picture. DWT is prerequisite of huge computational assets.

In this way, investigating the benefits of both calculations persuaded us to research structure is spoken to in Figure 3. The fundamental detriments of DCT are presentation of false molding impacts and blocking ancient rarities at higher pressure blend of DCT and DWT calculations. Such mix of two calculations is known as 'hybrid' calculation.

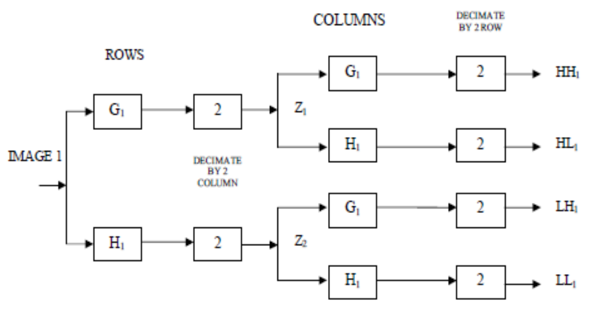

Figure 1: Filter bank structure of the DWT Analysis

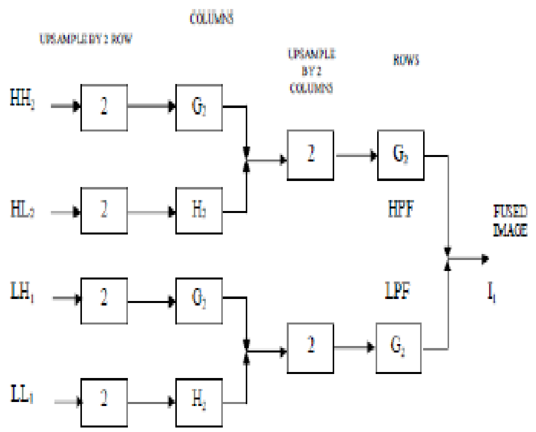

Figure 2: Filter bank structure of the reverse DWT Synthesis

The Hybrid techniques coordinating the points of interest of both DWT and DCT algorithms. Two mixes are formulated to use for picture compression strategies.

- Apply DWT calculation to get a lot of 4 decayed recurrence band coefficients for every picture.
- For each separate image's deteriorated recurrence band coefficients, apply FDCT wrapping change to get particular curvelet descriptor coefficients of all arrangement of deteriorated coefficients.
- To recover, sets of recurrence groups from above stage's resultants are connected with converse FDCT wrapping to particular coefficients.
- After getting a lot of four recurrence coefficients, apply converse DWT to recreate the last picture.
- Using input picture as reference picture and last picture, assess the execution of the calculation
- The information picture is read and its size is extricated.
- If image read is color image, then it is changed over into a gray scale picture

The Hybrid DCT-DWT Algorithm is given as beneath:

- The information picture (image) is read and its size is extricated.
- If image read is color image, then it is changed over into a gray scale picture.
- Apply DCT calculation to get a compacted picture to get particular curvelet descriptor coefficients of all set of deteriorated coefficient.
- Now apply DWT calculation to get a lot of 4 deteriorated recurrence band coefficients for each picture.
- After getting a lot of four recurrence coefficients, apply reverse DWT to recreate the last picture.
- For each particular image's decayed recurrence band coefficients, apply FDCT wrapping to changes.
- To recover, sets of recurrence groups from above stage's resultants are connected with reverse DCT wrapping to particular coefficients.
- Using input picture as reference picture and last picture, assess the execution of the calculation. The means are marginally changed at the progression of applying the change systems in the stream graph appeared in figure 1. The relating DCT, DWT, Hybrid DWT-DCT and Hybrid DCT-DWT calculations are supplanted in the change strategies connected in the stream outline.

4. SHAPE ADAPTIVE DISCRETE WAVELET TRANSFORM

There are two different types in the SA-DWT. One is a way to deal with arrangement with wavelet changes for optional length picture pieces. The other is a sub sampling strategy for self-self-assured length picture sections at self-confident territories. The SA-DWT licenses odd-or little length picture bits to be deteriorated into the change zone relatively to the even-and long-length pieces, while keeping up the sum of coefficients in the change space unclear to the measure of pixels in the image zone. The span of the change zone coefficients inside each sub band is the equivalent to avoid sharp changes in sub bands. A suitable sub sampling procedure is basic for the SA-DWT too. One idea is that it should spare the spatial association and self-comparability property of wavelet changes so 2-D (even and vertical headings) separable wavelet deteriorations and pyramid wavelet disintegrations can at present be associated with the discretionarily framed picture zone without loss of spatial relationship. Another musing is the effect of the sub sampling procedure on the capability of zero tree coding.

Algorithm for 2-D Shape-Adaptive DWT's:

Based on the length-adaptive wavelet transform algorithms and the sub sampling strategies discussed above, the 2-D SA-DWT (pyramid decomposition) for an arbitrarily shaped visual point can be described as follows.

1) Within the bounding box of the arbitrarily shaped object, use shape information to identify the first row of pixels that belongs to the object to be transformed.
2) Within each row, identify the first segment of consecutive pixels.
3) Apply the length-adaptive 1-D wavelet transform to this segment with a proper sub sampling strategy.
4) The low pass wavelet coefficients are set into the relating rows in the low-pass band. The high-pass wavelet coefficients are placed into the corresponding row in the high-pass band
5) Perform the above operations for the next segment of consecutive pixels in the row.
6) Perform the above operations for the next row of pixels
7) Perform the above operations for each column of the low-pass and high-pass objects.
8) Perform the above operations to the low-pass–low-pass band object until the level of wavelet decomposition is object).

5. RESULTS

A. Barbara Image

The algorithms were developed with MATLAB programming and analyzed for *Barbara* image shown in figure 5.1.

Figure. 5.1. Original Image

The compressed images are shown in Figure 5.2 for DCT algorithm and in Figure 5.3 for DWT algorithm.

Figure 5.2. DCT Compressed Image

Figure 5.3. DWT Compressed Image

Figure 5.4 & Figure 5.5 shows the DCT-DWT compressed image and DWT-DCT compressed images respectively.

Figure 5.4.Hybrid DCT- DWT Compressed Image

Figure 5.5: Hybrid DWT-DCT Compressed Image

Table 1 gives the comparison between the four algorithms, i.e., DCT, DWT, Hybrid DWT-DCT and Hybrid DWT-DCT Algorithms. The parameters used for Comparison are CR (Compression Ratio), MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio.

The Compression Ratio is defined as the ratio of uncompressed data volume (Suncomp) to the compressed data volume (Scomp).

Hence CR = Suncomp / Scomp

The MSE (mean square error) gives the noise approximation of the compressed image by using the eqn. (3).

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad \dots (3)$$

The PSNR (peak signal to noise ratio) is a measure of quality of reconstruction of compressed images by using the eqn. (4) as

$$PSNR = 10 \text{ Log}_{10}(MAX_I^2 / MSE)$$
$$= 20 \text{ Log}_{10}(MAX_I/SQRT(MSE))$$
$$= 20 \text{ Log}_{10}(MAXI) - 10 \text{ Log}_{10}(MSE) \quad \ldots\ldots (4)$$

Table 1. Comparison between three PFDs for Barbara image.

Compression method	Mean square error (MSE)	Compression ratio(CR)	Peak signal to noise ratio (PSNR)
DCT	123.6923	9.6043	27.207
DWT	21.2421	7.8280	34.8590
Hybrid DWT-DCT	126.1526	9.5739	27.1218
Hybrid DCT-DWT	19.5409	9.2948	35.2241
SA-DCT	18.1123	9.2511	33.2314
SA-DWT	18.1231	8.2412	34.1241

B. Cameraman image

The algorithms are developed in MATLAB and are analyzed for cameraman image shown in Figure 5.6.

Figure 5.6: Original cameraman Image

The images after compression are shown in Figure 5.7 for DCT algorithm and in Figure 5.8 for DWT algorithm.

Figure 5.7: DCT Compressed Image

Figure 5.8: DWT Compressed Image

The compressed images are shown in Figure 5.9 for Hybrid DCT-DWT algorithm, figure 5.10 for Hybrid DWT-DCT algorithm.

Figure 5. 9: Hybrid DCT-DWT Compressed Image

Figure 5.10: Hybrid DWT-DCT Compressed Image

Table 2. Comparison between three PFDs for Cameraman

Compression Method	Mean Square Error (MSE)	Compression Ratio(CR)	Peak Signal to Noise ratio(PSNR)
DCT Algorithm	124.9791	13.3745	27.1624
DWT Algorithm	21.4224	20.5696	34.8221
Hybrid DWT-DCT Algorithm	124.8890	13.0239	27.2193
Hybrid DCT-DWT Algorithm	12.3354	12.7055	37.2193
SA-DCT	61.3197	15.4490	33.0411
SA-DWT	61.3197	14.9107	24.6771

6. CONCLUSION

The lossy compression calculations are utilized to conquer the expansive speed transfer and tremendous storage where the data in the information with extensively less bits. The calculations picked for execution are DCT and DWT calculations. Because of restrictions like DCT presents false molding impacts and squares curios at higher compression, and DWT requires extensive computational assets. The idea of hybridization developed which get better advantages then DCT and DWT .Hybrid DWT-DCT technique has least mean square error (MSE) and enhanced compression ratio. Hybrid DCT-DWT calculation has great PSNR.SA-DWT is used for the case of noisy images.

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