# The LossLess Image Compression Techniques : A Review

Priya Bajpai
Department of Computer Science & engineering, PG Scholar, SRMCEM Lucknow

Dr. Pankaj Kumar
Department of Computer Science & engineering, Assistant Professor, SRMCEM Lucknow

Dr. Raj Gaurang Tewari
Department of Computer Science & engineering, Assistant Professor, SRMCEM Lucknow

*Abstract* - **The image compression is the technique which is applied to reduce size of the image without compromising image quality. The image compression is of two type which are lossy and loss-less type of image compression. This work is based on WDR and ASWDR algorithms which are used for the image compression. In this paper, these two algorithms are reviewed and it is been analyzed that ASWDR algorithm performs better in terms of various parameters**

## 1. INTRODUCTION

### A. Image Processing

It deals with the manipulation of digital images through a digital computer.It is a method to convert an image into digital form & perform some operations on it, in order to get an enhanced image or to extract some useful information from it.The purpose of image compression is visualization, image restoration, image retrieval & image recognition.Photoshop is an example of application for processing digital images. It is used in remote sensing,video processing, medical field,image sharpening etc

### B. Image Compression

As the multimedia based [1]web applications are increased so there is an increase in the required bandwidth & storage capacity.The solution to the problem is image compression .Image compression is a procedure by which the size of the image is reduced without degrading the image quality so that more images are stored in a given memory space. Image compression is of two types lossless & lossy. In case of lossless the compressed image is exactly same as original image. It minimizes the bit rate without distortion of the image Lossy image compression is used where some details of image can be lost to save bandwidth or storage space.

### C .Various image compression Techniques

Different algorithm for compression are DCT,DWT, Vector, quantisation, SVD etc.SVD is a method of image compression to discard the singular value with low amount of imageinfo[2].Here the image data is expressed in form of number of eigen values to perform compression.To meet low complexity 8 Pt DCT is used[3].Here the DCT approximation is based on polar decomposition methods The approximation transform is done to meet low complexity requirements as compared to dct and sdct hence reduces power consumption.In this 8 pt dct technique a modification to standard dct matrix by means of rounding off operation is done.This technique is useful for compression of images with high compression ratio.Another technique is the DWT[4] where the size of original image is decreased by estimating DWT coefficients below a certain value.It captures both location & frequency information.This technique first decomposes an image into coefficients called subbands & then these resulting coefficients are compared with threshold & the coefficients below threshold are set to 0 & rest are encoded using lossless image compression technique.It provides sufficiently high compression ratio and maintains image quality.In dwt the image is first divided into a set of high pass (detail) & low pass (approximate) coefficients.The image is first divided into blocks of 32*32. Each block is then passed through the filters: the first level decomposition is then performed to decompose the input data into an approximation &detail coefficients. After obtaining the transformed matrix,the detail & approximate coefficients are separated as LL,LH,HL & HH coefficients.All coefficients are discarded except the LL coefficients that are transformed into second level. The coefficients are then passed through a constant scaling factor to achieve the desired compression ratio.Another technique DCT image compression [5] is used for converting a signal into elementary frequency components.It attempts to de correlate the image data.After de correlation each transform coefficient can be encoded independently without losing compression efficiency.

### D. various challenges of image compression

The first issue is compression[6] because channel bandwidth is very expensive & how can one compress an image without severe loss to the quality of image is a challenge. Another challenge is to enhance an image which is severly degraded. It means if the image is of poor quality,contrast islow.Another issue is recognition where a recognition system needs to classify an unknown input pattern into one of the sets of prespecified classes. The problem arises when the number of classes is very large or if members in same class look very different.Thus challenge is how to recognize generic objects.Next challenge is visualization.The main task is to generate images or image sequences based on three-dimensional object and scene models.A challenging problem is how to model dynamic scenes containing nonrigid objects (such as

clothing, hair, trees, waves, clouds, etc.).  So the models have to be realistic, and yet the computation cost has to be reasonable.

## II. WDR AND ASWDR ALGORITHMS

### A.  WDR algorithm for  compression

Two different wavelet based techniques are WDR & ASWDR. wavelet transforms are widely studied  over the last decade [7,8]. WDR is a lossy technique. It is a method of efficient embedded image  coding. WDR retains all the important features like low complexity,region of interest, embeddedness  &  progressive  SNR.ASWDR  adapts scanning procedure used by WDR in order to predict locations  of  significant  transform  values  at  ½ threshold.Some of the compression techniques were used earlier[8]

.In WDR [9] technique firstly a wavelet transform is applied to the image.,after this the bit plane based WDR encoding algorithm for the wavelet coefficients is carried out. WDR [10] mainly consists of 5 steps as follows. The first step is initialization in which an assignment of a scan order is first made where a scan order is a one to one  & onto  mapping  f..= x k , for k=1,2,3….p, between the wavelet coefficient() & a linear ordering(x k).This scan order is a zigzag through subbands from higher to lower levels.For coefficients in subbands row based scanning , coloumn based scanning is used in the horizontal subbands & vertical subbands respectively. Zigzag  scanning is used for diagonal & low pass subbands. As the scanning  order is  made ,  an  initial Threshold $T_v$ is set so that all transformation satisfy IX 1< $T_v$& atleast one transform value satisfies IX1>= $T_v$/2.

In  the  second  step  update  threshold  by  T k= T k1/2.In the third  step of significance  pass the transform values are deemed significant if they are greater than or equal to the threshold value.Then their index values are encoded using WDR method [11].The difference reduction method  essentially consists of  binary encoding of the number of steps to go from the index of the last significant value to the index of the current significant value.The output from the significance pass includes the signs of significant values along with sequence ofbits generated by difference reduction which describes the precise locations of significantvalues. Last step is the refinement pass.It is to generate  the  refined  bits  via  the  standard  bit- plane quantisation procedure . Each refined value is better approximation of an exact transform value. Repeat second to last step until big budget is reached.

### B.  ASWDR algorithm for compression

ASWDR algorithm is a simple adaptation of the Wavelet Difference Reduction (WDR) algorithm of WDR [12] It is a modification WDR algorithm employs a hard and fast ordering of the positions of wavelet coefficients, so ASWDR [13] method employs a various order that aims to adapt itself to specific image features. The ASWDR adjusts the scanning order therefore as to predict locations of latest significant values. Scanning order of ASWDR dynamically adapts to the locations of edge details in an image, and this

increases  the  declaration  of  these  edges  in  ASWDR compressed    images.Hence,    ASWDR    shows    better perceptual qualities, especially at low bit rates, than WDR and SPIHT compressed images preserving all the features of WDR. The ASWDR modifies the scanning order which is used by WDR for achieving better performance.It is a lossy compession technique. It is a 7 step procedure. It is a modification of WDR algorithm.

The first step is to perform a wavelet transform of the image. In second step choosing of a scanned order for the transformed image is done whereby the transform values are scanned via linear ordering, the scanning order is zigzag through subbands  from lower to higher[14]. Row based scan  is used in low pass high pass subbands and coloumn –based scanning is used in the high pass/low pass subbands.

In the third step an initial threshold T is chosen, such that atleast one transform value has magnitude less than or equal to T & all transform values have magnitude less than 2T.In the fourth step of significant  pass. The recording position for new significant values is done. The significant values are the new indices m for which l*[m] 1 is greater than or equal to the present threshold. Encode these new significant indices using difference reduction.

In  the  fifth  step  i.e  refinement  pass  record refinement bits for significant transform values determined using larger threshold values.This generation of refinement bits is the standard bit plane encoding used in embedded codecs[13].

In the sixth step  i.e  new scan order. Run through the  significant  values  at  level  j  in  the  wavelet transform.Each significant value, called a parent value , induces a set of child values.-four child values  for  all levels except the last,& three child values for the last described in the quad-tree definition in [15].The first part of the  scan order at level j-1 contains the insignificant values lying among the child values. Run through the insignificant   values   at   level   j   in   the   wavelet transform.Second part of the scan order at level j-1 contains the insignificant values, atleast one of whose sibling is significant, lying among the child values induced by these insignificant parent values. The third part of the scan order at level j-1 contains the insignificant values, no of whose siblings are significant, lying among the child values induced by these significant parent values. In the last step divide the present threshold by 2. Repeat the steps 4-6 until either a bit budget is exhausted or a distortion metric is satisfied.

The PSNR values from reconstructed images by using  ASWDR  compression  is  higher  than  WDR compression. MSE values from reconstructed image by ASWDR  compression is lower than WDR compression. The  ASWDR  technique performs better than the WDR compression technique.

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TABLE I.  COMPARISION BETWEEN WDR & ASWDR  ALGORITHM

| WDR | ASWDR |
|---|---|
| The PNR value of reconstructed image for ASWDR is lesser than WDR. | The PSNR value of the reconstructed image for ASWDR is greater than WDR. |
| The MSE of reconstructed image for ASWDR is higher than WDR. | The MSE of reconstructed image for ASWDR is lower than WDR. |
| Performance of WDR in terms of performance parameters & coding with acceptable image quality  is not as good as ASWDR. | Better performance in terms of performance parameters & coding  with acceptable image quality as compared to WDR. |

## III.  LITERATURE REVIEW

Y.Wongsawat, h.ochoa, k.r Rao (2004): In this paper, modified  hybrid DCT-SVD image encoding system is used to encode both monochromatic and color images. The SVD requires high complexity to compute eigen values and vectors. DCT performs well for highly correlated image. Hence both are combined to obtain a hybrid DCT-SVD image coding algorithm (HDCTSVD). DCT is used when the standard deviation of an 8*8 sub block of image is below threshold else SVD [16] is used.To achieve better compression , chrominance components are then filtered by low pass filter then downsampled by a factor of 2, both horizontally  vertically. After that  Y,$C_B$ & $C_R$ components are encoded separately by MHDCTSVD. MHDCTSVD results better than  HDCTSVD in lower bit range because of AMVQ. MHDCTSVD also outperforms DCT due to optimal energy packing efficiency of SVD.

K.H Talukder and K. Harada (2007): In this paper they have discussed   Haar wavelet approach for image compression  on a low complex 2D image & quality assessment of the image is done after compressions. In the 2D image compression using Haar wavelet [17] from a given matrix a transformed   matrix is   obtained by following   operations   of   averaging   and differencing.Compression is   then obtained by wavelet coefficient thresholding using different thresholding techniques like soft thresholding, hard thresholding thresholding &universal thresholding. All coefficients below threshold are computed & neglected. Hard thresholding  method provides best compression ratio.The soft thresholding method performs better than universal threshoding in terms of compression ratio but it depends on choosing value of the threshold.

Prabhakar. Telagarapu, V.Jagan  Naveen(2011) : In this paper they have discussed  DCT and wavelet transform for image compression  is. DCT [18] attempts to decorrelate image data.In the proposed DCT algorithm the image is broken into 8*8 blocks of pixels.From left to right and top to bottom & then DCT is applied to each block. Each block

is then compressed through quantisation.When desired image is reconstructed through decompression, which uses inverse discrete cosine transform(IDCT).Wavelet transform is a method to represent a signal in time-frequency form. Wavelet transform are based on small waves, called wavelets,of   varying   frequency   and   limited duration.Wavelet transform uses multiple resolutions where different frequencies are analysed with different resolutions. Result here show that PSNR VALUES for DWT are higher and MSE values are lower than that of DCT based compression. Overall performance of DWT is better than DCT on the basis of compression rates.

M.M.H. Chowdhury and A Khatun(2012): In this paper they have discussed about the discrete wavelet technique of image compression. They have also compared the performance of DWT with other techinques. Proposed technique is based on the discrete wavelet transformation [19] that gives less complexity and also maintains image quality. Here the image is first decomposed into coefficient called subbands and then compared with threshold. Coefficients lesser than threshold are set to zero while rest are encoded with a lossless compression technique.It provides sufficiently high compression ratio with almost no degraded quality. It has a better performance than other compression techniques.

Ramandeep Kaur & Navneet Randhawa (2012): In this paper they have discussed the hybrid technique of DCT & DWT [20] for image compression. It is specifically used for the compression of images where there is tolerable degradation allowed. The algorithm used performs the discrete cosine transform (DCT) on the discrete wavelet transform(DWT) coefficients and then discards majority of high coefficients to obtain compression.The results using this hybrid technique shows improved performance as compared to JPEG based DCT.This performs better in noisy  environment & reduces false contouring effects & blocking artifacts significantly.

S.Kahu & R.rahate (2013): In this paper they have discussed image compression technique svd[21]. It is based on the factor k which represents the number of eigen values . The factor K impacts the quality of image.If k is equal to the rank of  matrixthen amount of compression is very less & quality is nearly same as original image.As k increases image quality improves but more storage space is required. In case  the value of k is smaller the compression ratio is more but image quality deteriorates. Therefore it is necessary to choose value  of k depending on  requirement of storage or image quality. As the value of  k is increased smaller MSE & larger PSNR can be seen  but more storage space  required.In case of Smaller value of k then compression ratio is high but image quality decreases ie larger mse & smaller PSNR . So Degree of compression varies with value of k. Svd gives good compression result with less computational complexity compared to other techniques.

K. saraswathy, D vaithiyanthan & R. seshasayanan (2013): In this paper they have discussed about the orthogonal approximation of the 8 pt DCT [22] . DCT approximation is based on polar decomposition methods.The approximation transform is done to meet low complexity requirements as compared to dct and sdct hence reduces power consumption. In dct we leave the unwanted frequency components while retaining required ones. In the proposed technique  a modification to standard dct matrix by means of rounding off operation  is done. This proposed technique is useful for compression of images with high compression ratio.The reconstructed images have better quality and higher  PSNR values as compared to the DCT and  SDCT.

Alok Kumar Singh & G.S Tripathi (2014):  In this paper they have done a comparative study of DCT, DWT &Hybrid(DCT-DWT)[23] .Transform on thebasis of parameters compression ratio(CR), mean square root(MSE) , peak to signal ratio (PSNR).The individual DCT & DWT tchniques are  also discussed  along with the procedure of hybrid technique. The  result  show  that    a  higher compression ratio is achieved using hybrid technique but loss of information is more in this case.The table given below summarizes the literature work.

| AUTHOR | YEAR | DESCRIPTION | OUTCOMES |
|---|---|---|---|
| Y. Wongaswat ,H. ochoa  &  K.R  Rao | 2004 | The modified hybrid DCT-SVD image encoding system is used  here to encode Monochromatic & colored images and  is compared with conventional hybrid DCT-SVD. | 1.) Modified HDCT SVD is better than HDCTSVD  in terms of image quality at low bit rate. <br><br> 2).  Modified   HDCTSVD results better than DCT due to optimal energy packing efficiency of SVD. |
| K.H Talukder & k. Harada | 2007 | Describes about haar wavelet approach of image compression on 2 D image & it's quality assessment after compression. | 1. Hard threshold method provides best compression ratio. <br><br> 2. Soft threshold method gives better compression ratio than universal threshold method. <br><br> 3. PSNR value for soft threshold method is more than hard threshold for a given threshold value. |
| Prabhakar .Telagarapu, V. Jagan Naveen | 2011 | It describes DCT & Wavelet transform of image compression. | 1) PSNR values for DWT are higher & MSE are lower than DCT. <br><br> 2). Performance of DWT is better than DCT. |
| Ramandeep kaur & Navneet Randhawa | 2012 | It describes about the hybrid DCT & DWT technique of image compression under high compression ratio constraint. | 1).The performance is improved as compared to the  individual techniques. <br><br> 2). It reduces the false contouring effects & blocking artifacts |
| M.M.H Chowdhury  &  A. Khatun | 2012 | Describes about  DWT technique of image compression in which coefficients of the images are compared with threshold & coefficients which are  lesser are then discarded for compression. | 1). DWT technique has less complexity . <br><br> 2).DWT provides high compression ratio. <br><br> 3).DWT has better performance than DCT & other techniques. |

## IV    CONCLUSION

In this paper, it is been concluded that image compression reduce size of the image. The various techniques has been designed in the recent times, for the efficient image compression. This paper is based on the WDR and ASWDR image compression technique and it is been concluded that ASWDR is the most advance type of compression technique which can be enhanced in future.

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