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Image and Video Compression using Discrete Wavelet Transform Matlab Results

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Abstract - Image compression reduces the amount of data required to represent an image by removing redundant information. Today compression is very necessary because dependency on computer increasing day by day. . This is because the amount of space required holding uncompressed image costs more. Fortunately, there are several methods of image compression available today. Although Video looks like continuous motion, it is actually a series of still images. In this paper DWT method applied for image and video compression. We also calculated the PSNR and CR values after image reconstruction using IDWT algorithm.

Keywords: Image compression, video compression, Discrete Wavelet Transform (DWT), Inverse Discrete Wavelet Transform (IDWT), Peak signal Noise Ratio (PSNR) and Compression Ratio (CR).

1. INTRODUCTION:

One image equals more than thousand words, unfortunately storing image costs more than million words. Image compression is important for webmasters who want to create faster loading web pages which in turn will save a lot of bandwidth. Image compression is important for people who attach photos to emails which will send the email more quickly, save on bandwidth costs and not make the recipient of the email angry. Therefore, compression is necessary and essential method for creating image files with manageable and transmittable sizes.

Video is a series of still images which are called frames [5].The consumers using digital video increasing day by day, so video compression is necessary to reduce the size. Video compression has two important benefits. First, it makes it possible to use digital video in transmission and storage environments that would not support uncompressed video for example current Internet throughput rates are insufficient to handle uncompressed video in real time. A DVD can only store a few seconds of uncompressed video so video storage would not be practical without video and audio compression. Second video compression enables more efficient use of transmission and storage resources. If a high bit rate transmission channel is available, then it is more attractive proposition to send a high resolution compressed video or multiple compressed video channels than send a single, low resolution, uncompressed stream.

Even with constant advances in storage and transmission capacity, compression is likely to be an essential component of multimedia services for many years to come. In a lossless compression system statistical redundancy is removed so that the original signal can be perfectly reconstructed at the receiver. Unfortunately, at the present time lossless methods can achieve only a modest amount of compression of image and video signals. Most practical video compression techniques are based on the lossy compression, in which greater compression is achieved but decoded signal not identical to the original. The goal of video compression algorithm is to achieve efficient compression with less loss.

2. ONE-DIMENSIONAL DWT AND IDWT ARCHITECTURE

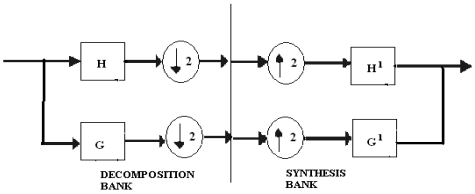


Figure1. One Dimensional DWT and IDWT

The generic form of 1 D DWT is shown in above figure [3]. Here the discrete signal is passed through a low pass and high pass filters H and G then down sampled by factor 2 completes forward wavelet transform.. The inverse is obtained by up sampling by a factor of 2 and then using the reconstruction filters H^1 and G^1. The low pass (H) and high pass filter (G) combined called as decomposition (analyze) filter bank [6]. The low pass (H^1) and high pass (G^1) filters combined called as Synthesis filter bank [6]. Analyze filter banks used for compression and synthesis filter bank used for decompression.

3. TWO-DIMENSIONAL DWT AND IDWT ARCHITECTURE

Image is two dimensional signal which is denoted by X (m, n) here m is number of rows and n is number of columns. So for image compression, first we apply DWT algorithm to rows followed by columns. We can inter change the order of rows and columns means we first apply DWT algorithms to column first followed by rows next. Similarly, IDWT algorithm also applied to columns followed by rows completes the reconstruction of image. The following figure shows the level one DWT and IDWT architecture for images [3], [4].

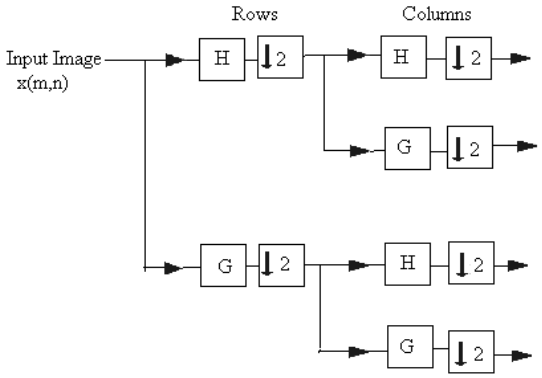


Figure2. Level One DWT for images

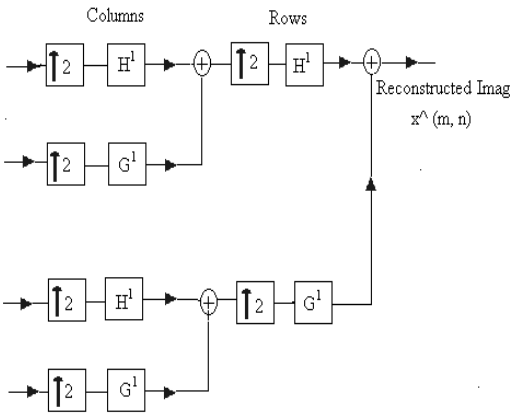


Figure3. Level One IDWT for images

The output values of high pass filter are called as 'detail coefficients' [3] and the output values of low pass filter called as approximate coefficients [3]. Detail coefficient values are less significant in image reconstruction even though we neglect these values we get back original image with less loss.

4. COMPRESSION RATIO AND PSNR

Benchmarks in image data compression are the compression ratio and PSNR (Peak Signal to Noise Ratio)[5]. The compression ratio is used to measure the ability of data compression by comparing the size of the image being compressed to the size of the original image. The greater the compression ratio means the better the wavelet function. PSNR is one of the parameters that can be used to quantify image quality [8]. PSNR parameter is often used as a benchmark level of similarity between reconstructed image and the original image. Larger PSNR will produce better image quality [1].

$$\text{Compression Ratio} = \frac{\text{The size of compressed image}}{\text{The size of the original image}} \quad \text{--- (1)}$$

PSNR defined as follows [1], [2]

$$PSNR = 10 \cdot \log_{10} \left| \frac{255}{\sqrt{MSE}} \right| \quad \text{--------- (2)}$$

Where MSE is mean square error,

$$MSE = \frac{1}{M \cdot N} \left\{ \sum_{m=1}^{M} \sum_{n=1}^{N} \left(X(m,n) - \hat{X}(m,n) \right)^2 \right\} \text{---- (3)}$$

5. IMAGE COMPRESSION RESULTS

5.1 Level – One Compression results

Figure 4 (a) baboon image

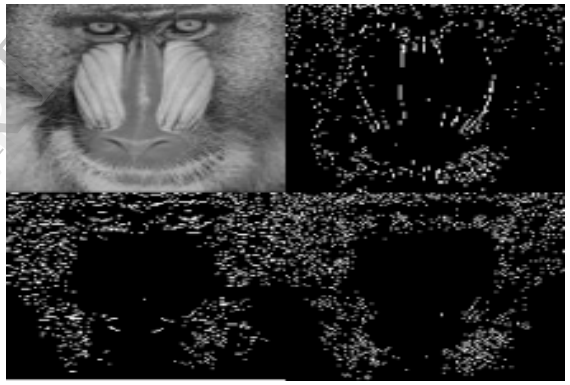


Figure 4 (b) Level one DWT

(Detail coefficient values enhanced by thresholding)

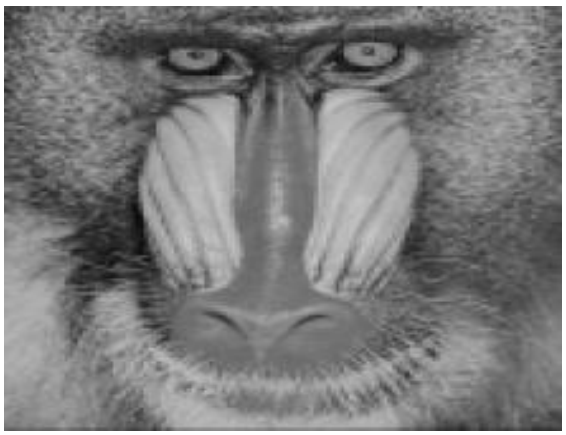


Figure 4 © Reconstructed image

(Only Approximate coefficient values are used)

Figure 4 (d) Difference between original and reconstructed

(Coefficient values enhanced by thresholding)

Here I got the compression Ratio of '4' and PSNR of 34.1 db. Here the detail coefficients values are enhanced for better view. Thresholding mechanism is used to enhance the values. Here threshold value is 20 means all coefficients above the 20 are forced to 255 and below 20 are forced to zero.

5.2 Level – Two Compression Results

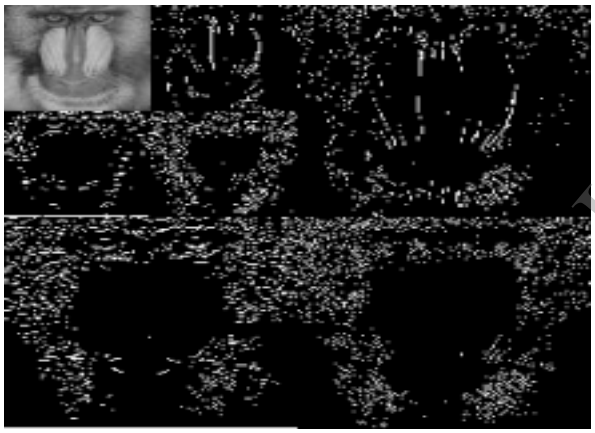


Figure 5(a) Level Two DWT image

(Detail coefficient values enhanced by thresholding)

Figure5 (b) Reconstructed image

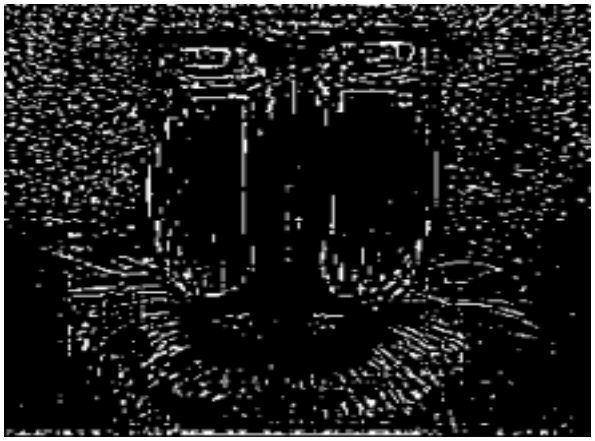


Figure 5© Difference between original and reconstructed

(Coefficient values enhanced by thresholding)

Here I got the compression Ratio of '16' and PSNR of 32.44 db. Here the detail coefficients values are enhanced for better view with threshold value of 20.

The difference between original and reconstructed image (fig 5©) increased in level two DWT results compared to level one DWT results (fig 4(d)). Observe that PSNR value is decreased in level two DWT means the reconstructed image quality is less. As compression ratio increases, the reconstructed image quality decreases.

6. Video Compression Results

6.1 Level - one Video Compression Results

Although it looks like video is continuous motion, it is actually a series of still images, and changing fast enough that it looks like continuous motion, so video compression is similar to image compression. Video compression is done when we compress all the frames in that video. Here I have taken the VIP TRAFFIC video which consists120 frames in it. Here some of frames results have showed.

Figure 6(a) some frames in Video Traffic

Figure 6(b).Level one DWT for frames

(Detail coefficient values enhanced)

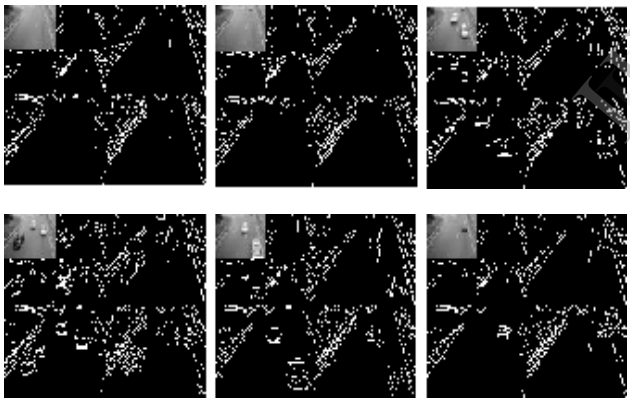
PSNR=39.83 db PSNR=39.83 db PSNR=38.02 db

PSNR = 38.35 db PSNR=39.83 db PSNR= 36.74 db

Figure 6© Reconstructed frames with PSNR values

(only approximate coefficients are used)

6.2 Level – Two Video Compression Results



7(a).Level –Two DWT for video frames

PSNR=32.84 db PSNR=32.84 db PSNR=33.10 db

PSNR = 33.29 db PSNR=34.45 db PSNR= 33.84 db

Figure 7(b).Reconstructed frames with PSNR values

(only approximation coefficients are used)

Compression Ratio (CR) is 4 for one level compression and 16 for two level compressions. PSNR value decreasing in level two compressions compared to level one compression, it means the reconstructed image quality decreasing and error between original and reconstructed image is increasing. Larger PSNR will produce better image quality.

CONCLUSION

Digital video compression techniques have played an important role in the world of telecommunication and multimedia systems where bandwidth is still a valuable commodity. Hence, video compression techniques are of prime importance for reducing the amount of information needed for picture sequence without losing much of its quality, judged by human viewers. Here we have used Discrete Wavelet Transform (DWT) to achieve the compression for image and it extended to series of images which is nothing but a video.

PSNR and Compression Ratio calculated in this paper. PSNR value is decreasing as the compression ratio increasing, means the reconstructed image quality is decreasing.

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