Proposed IDWT architecture based on MATLAB results

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ABSTRACT
This paper proposes architecture for IDWT (Inverse Discrete Wavelet Transform) in spatial domain. The architecture is based on MATLAB results of IDWT. The reconstruction of compressed image has been done using fixed point, floating point methods & standard IDWT function in MATLAB. The comparison between results was made based on standards like SNR (Signal to Noise Ratio), MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio).

General Terms
Digital Image Processing, Inverse Discrete Wavelet Transform

Keywords
IDWT, Image Decompression, digital image processing, Wavelet, Spatial domain.

1. INTRODUCTION
A majority of today's Internet bandwidth is used for images and video. Recent multimedia applications for handheld and portable devices place a limit on the available wireless bandwidth. The bandwidth is limited even with new connection standards. JPEG image compression that is in widespread use today took several years for it to be perfected. Wavelet based techniques such as JPEG2000 for image compression has a lot more to offer than conventional methods in terms of compression ratio. Currently wavelet implementations are still under development lifecycle and are being perfected. Flexible energy-efficient hardware implementations that can handle multimedia functions such as image processing, coding and decoding are critical, especially in hand-held portable multimedia wireless devices [5][6].

2. WHY WAVELET
Wavelets are small wavelike signals with zero average value. It provides time verses frequency representation of any signal. It helps to represent an arbitrary function as a superposition of wavelets. Therefore Discrete Wavelet Transform is more accurate in analysing images at different spatial frequencies than Fourier based transforms [5].

2.1 Method used
Discrete Wavelet Transform when performed in spatial domain uses the concept of averaging and difference as compared to high-pass & low-pass filter methods used in frequency domain. DWT involves dividing the image vertically into two halves containing Averaging & Difference components. The same image is then divided horizontally into averaging & difference components again; this time the 4 blocks formed are Average-Average, Average-Difference, Difference-Average & Difference-Difference. The two iterations can be reduced to 4 single equations. The process is depicted in the figure shown below:

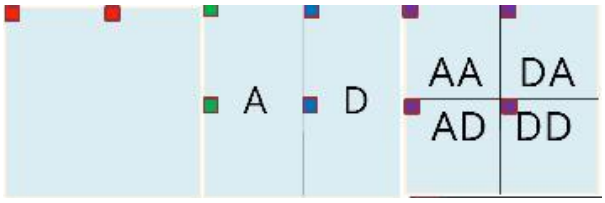

Fig. 1 a,b,c

1. Original image with 2 red spots are pixels to be considered.
2. Second image shows first stage of image division into average & difference components.
3. Third image shows 4 blocks with divisions discussed earlier.

3. INVERSE DISCRETE WAVELET TRANSFORM
The third image shown above is transmitted to the receiver. At the receiving side the original image is reconstructed by following methods:

3.1 Floating point reconstruction:
This method involves using the 4 equations and reconstructing the original image back without any significant changes in the equations. This provides the floating point reconstructed image.[1][2]

3.2 Fixed point reconstruction:
This method involves converting the floating point values into fixed point by rounding up the numbers after multiplying it by 1000. After the equations are performed on the pixels the image is reconstructed from them after dividing by 1000.

3.3 Using Matlab functions:
This method involve the use of Matlab function dwt2() to compress an image and reconstruct it back using idwt2() function.

A visual comparison can be made using the above methods. It is shown below:

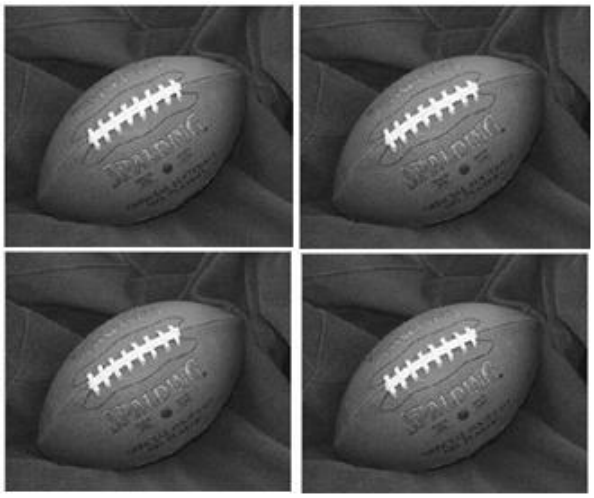

Fig. 2 a b

c d

1. Original 512 x 512 image
2. Fixed point reconstructed image.
3. Floating point reconstructed image
4. idwt2() function reconstructed image

According to the visual comparison no remarkable change in quality is observed. Though floating point and fixed point reconstruction is done using equations even then it is difficult to find out the best possible method. It may require comparison based on various parameters like Signal to Noise Ratio (SNR), Mean Square Error (MSE) & Peak Signal to Noise Ratio (PSNR).

4. COMPARISON BASED ON PARAMETERS

Table 1. Parametric Comparison

Parameters	Reconstruction methods		
	Fixed point	Floating point	Standard idwt()
SNR (Signal to Noise Ratio)	Inf + 13.5895i	Inf+5.6910i	Inf+24.8006i
MSE (Mean Square Error)	1.2987 e-009	1.3241 e-033	1.0839 e-032
PSNR (Peak Signal to Noise Ratio)	177.7296	657.5615	639.2999

From the above table it can be figured out that Fixed point reconstruction seems to be the method which can be used to form an IDWT system which can be implemented on FPGA.

5. PROPOSED ARCHITECTURE

Below mentioned diagram is the proposed architecture for Inverse Discrete Wavelet Transform (IDWT) system based on Fixed–point reconstruction method.

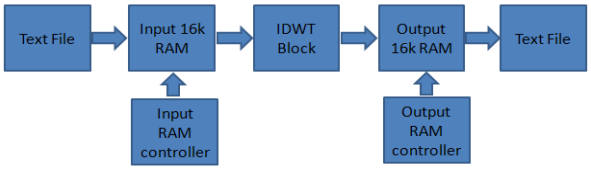

Fig. 3 Proposed Architecture for IDWT system.

The architecture shows input and output RAM of same size. Each RAM is associated with a controller. The RAM saves hex data of a text file which is nothing but pixel values of image to be reconstructed. According to the addresses generated by the controller; RAM sends pixels to IDWT System unit. All the processing is done in the main system unit. After processing, the resultant values are saved in another RAM. Its controller helps to resend the pixel values to IDWT system unit for reprocessing. After the overall processing is done, the data is saved to a text file. Image can now be constructed from the data in text file.

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7. REFERENCES

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