IMPACT: International Journal of Research in
Humanities, Arts and Literature (IMPACT: IJRHAL)
ISSN (P): 2347–4564; ISSN (E): 2321–8878
Vol. 7, Issue 4, Apr 2019, 743–750

A NOVEL DCT ARCHITECTURE FOR IMAGE PROCESSING APPLICATIONS

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Received: 19 Apr 2019 **Accepted:** 27 Apr 2019 **Published:** 30 Apr 2019

ABSTRACT

Now days for image transmission applications the compression technique is a necessary technique. To transmit the image with high quality factor and high efficiency, multiple compressions is used. When the image is compressed, the discrete cosine transform is applied on an image and then IDCT is applied for image restoration. The image is compressed multiple times and the quality factor is estimated each and every compression by obtaining the PSNR, MSE and SSIM. For the quality image PSNR value should be high and the MSE value should be non-negative value. The efficiency of the DCT algorithm is measured by calculating the process time of the algorithm. Hence novel discrete cosine transform architecture for compression is designed. Power consumption of the DCT algorithm is calculated by using the Xilinx ISE 8.1i.

KEYWORDS: *Image Compression, PSNR (Peak Signal To Noise Ratio), MSE (Mean Square Error), SSIM (Structural Similarity), DCT (Discrete Cosine Transform), IDCT (Inverse Discrete Cosine Transform), Power Consumption And Area, Xilinx ISE 8.1i.*

INTRODUCTION

Compression Methods

The main objective of the image compression is to reducing the size by reducing the redundancy. Image compression is used to transmit and store the data in an efficient manner. There are two methods for image compression one is lossy and another one is lossless compression technique. Image compression contains three types of redundancies. They are given as follows:

- Coding Redundancy : Gray levels of the images uses more coded symbols than they really needed
- Inter Pixel Redundancy: Neighboring pixels have almost same value.
- Psycho Visual Redundancy: Human eye does not respond to all visual information.

Lossy Compression Technique

In this compression technique, the compressed image is not remains same as the original image. In the lossy compression the data and information is loss while compression technique is applied. Several methods are available for the lossy compression such as Transform coding, Fourier transform, Discrete Cosine Transform and Discrete Wavelet Transform.

Lossless Compression Technique

Lossless compression technique is a compression technique which is a class of data compression algorithm. It allows the original data is perfectly reconstructed from the compressed data. Lossless data compression is used in various applications. It includes Huffman coding, Entropy coding, Run length coding, Bit plane coding.

LITERATURE SURVEY

Along the years, various DCT strategies have been developed. Yamini Ravella [3] using the probabilistic approach for designing the low power accuracy substitution circuit. In this approach probabilistic adders save up to 60 % of power compared to the conventional adders. Uday Bhade, Sanjeet Kumar, Prashant dwivedy, Shahbaz Soofi, Vainest Ray [2] explains the comparative study of DWT, DCT, BTC and SVD techniques. Various image compression parameters like PSNR, MSE, SSIM and CR are obtained and compare the parameters with one another. Nehal Markandeya, Sonali Patil[4]

Images are compressed by using BTC and DCT. Block truncation coding is for the images having gray scale. It reduces the space for the storage values equal to 0 to 7. Ankit Chouhan and M.J Nigam explains about the double compression it is done by different quantization matrices and obtaining the PSNR, CR, MSE for an image. Tiango Schiavony, Guilherme Paim, Mateus Fonsecaz, Eduardo Costay and Sergio Almeiday [9] explain the adders, sub tractors, for live images and multipliers for standard images. DCT is used for the compression. Then the equation for $D(i, j)$ will be given as follows:

$$D(i,j) = \frac{1}{4}c(i)c(j)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} p(x,y)\cos\left[\frac{(2x+1)i\pi}{16}\right]\cos\left[\frac{(2x+1)j\pi}{16}\right]$$

Discrete Cosine Transform Algorithm

Inverse Discrete Cosine Transform

The most common form of image compression technique is Discrete Cosine

Compression technique is Discrete Cosine transform. The discrete cosine transform separates the lower and higher frequencies co-effients and higher frequencies are less sensitive so it is treated as redundant data. Quantization is a part of compression which occurs when the less frequency components are discarded. By the images reconstruction the important frequencies are retrieved by applying inverse Discrete Cosine Transform.

The IDCT is the inverse function of the discrete cosine transform and it reconstructs a sequence from its discrete cosine transform coefficients. The equation of the IDCT is given as follows:

$$D(i,j) = c(i)(j)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} p(x,y)\cos\left[\frac{(2x+1)i\pi}{2N}\right]\cos\left[\frac{(2x+1)j\pi}{2N}\right]$$

Process of Discrete Cosine Transform

- Image is spitted into 8×8 blocks of pixels.
- DCT technique is applied for each block.
- Compression of each block is done by quantization.
- Storage space of the image is reduced while applying the compression technique.
- Inverse DCT is applied for image retrieval.

Equation for DCT

The equation for DCT is given as,

$$D(i,j) = \frac{1}{\sqrt{2n}} c(i)c(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} p(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2x+1)j\pi}{2N}\right]$$

$$c(u) = \begin{cases} \frac{1}{\sqrt{2}} \; if \; u = 0 \\ 1 \; if \; u > 0 \end{cases}$$

PROPOSED WORK

In a proposed work multiple time of compression is applied to increase the quality of the image. When the image is multiple times compressed, peak signal to noise ratio is evaluated and the mean square error value is obtained to estimate the quality of image. Peak to signal ratio should be high for the good quality image and then the mean square error value should be non-negative. The efficiency of the algorithm is obtained by measuring the execution time of an algorithm. Time is evaluated for each and every stage of compression by adding tic and toc function. The stage by stage compression and the image parameter values for estimating the quality of image is shown in the Figure 1, 2, 3 and 4.

Fig. 1.3 shows the power report taken from the Xilinx ISE 8.1i which gives the initial power report for a novel DCT architecture.

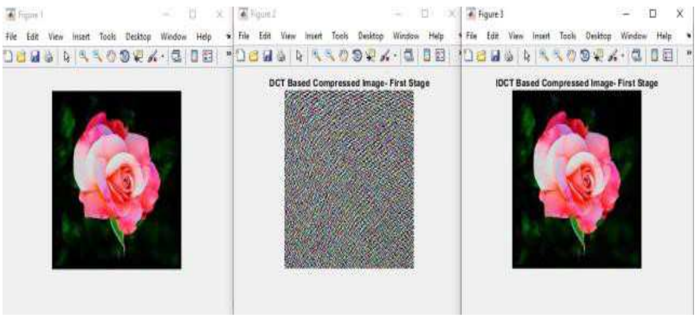

Figure 1: First Stage of Compression.

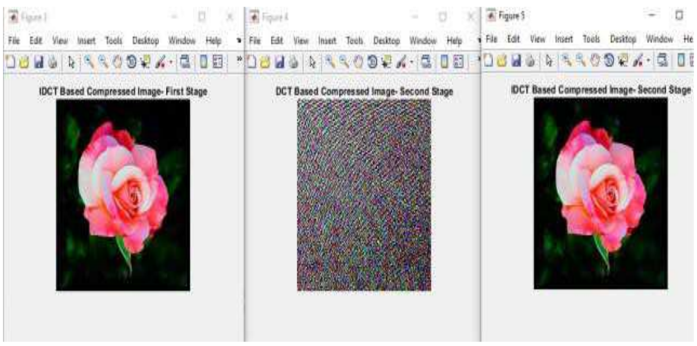

Figure 2: Second Stage of Compression.

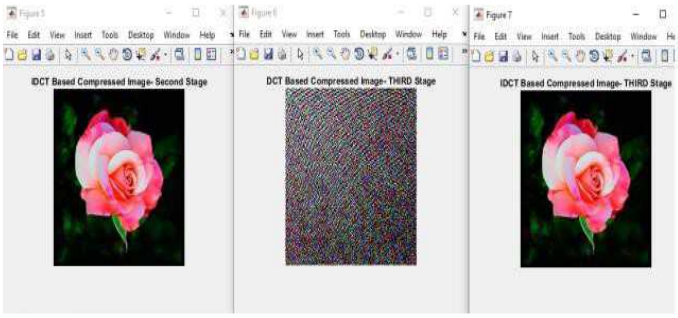

Figure 3: Third Stage of Compression.

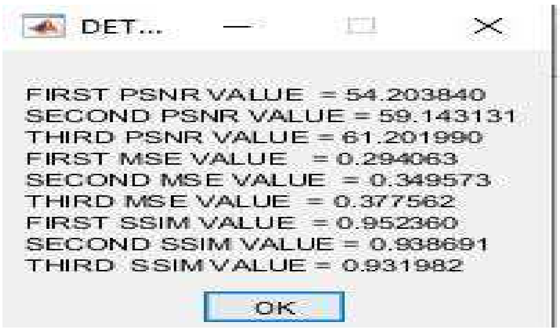

Figure 4: Image Parameters.

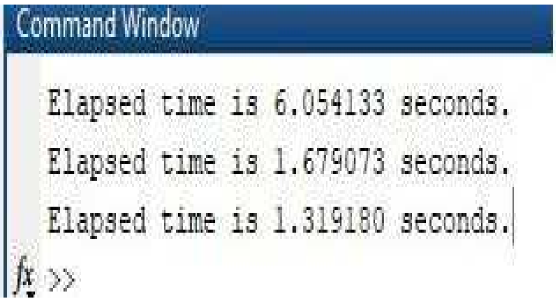

Figure 5: Execution Time for the Algorithm.

```
Power summary:                               I(mA)    P(mW)
-----------------------------------------------------------
Total estimated power consumption:                     34
                                   ---
                      Vccint 1.80V:           15       27
                      Vcco33 3.30V:            2        7
                                   ---
                           Clocks:             0        0
                           Inputs:             0        0
                            Logic:             0        0
                          Outputs:
                             Vcco33            0        0
                          Signals:             0        0
                                   ---
           Quiescent Vccint  1.80V:           15       27
           Quiescent Vcco33  3.30V:            2        7
```

Figure 6: Power Analysis.

RESULT ANALYSIS

The image parameter analysis is shown in the Figure 5, 6 and Fig. 7.

The Table 1 shows the comparison of the peak signal to noise ratio, mean square error value and the structural similarity value and also it shows the execution time for each stage of compression.

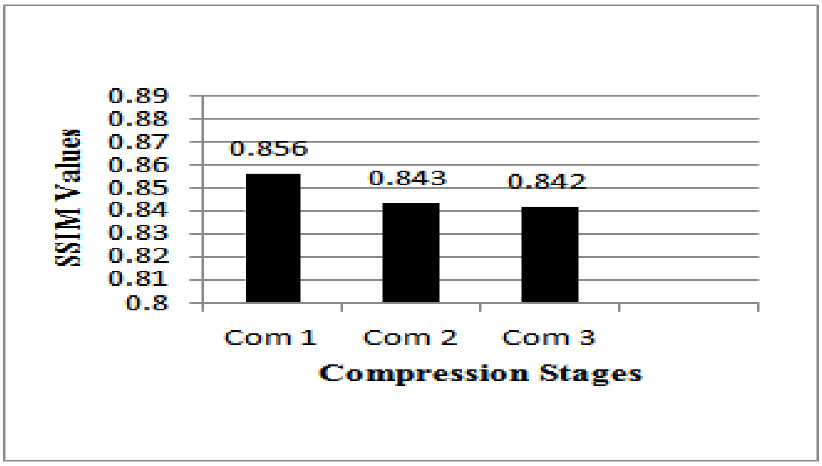

Figure 7: Analysis of SSIM for the Flower Image.

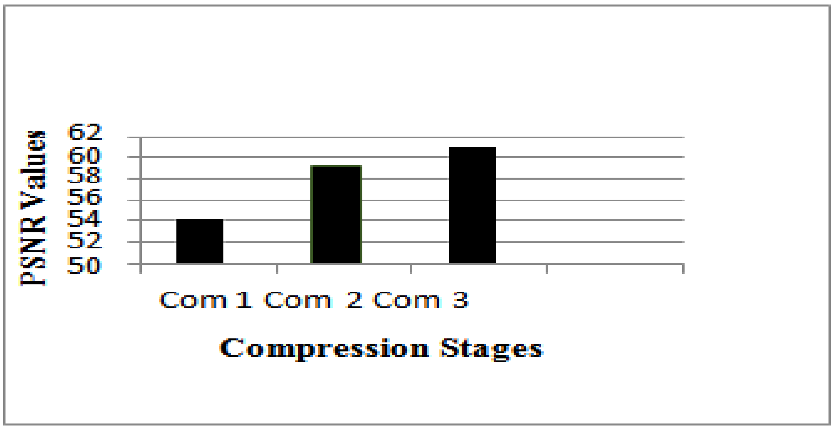

Figure 8: Analysis of PSNR for the Flower Image.

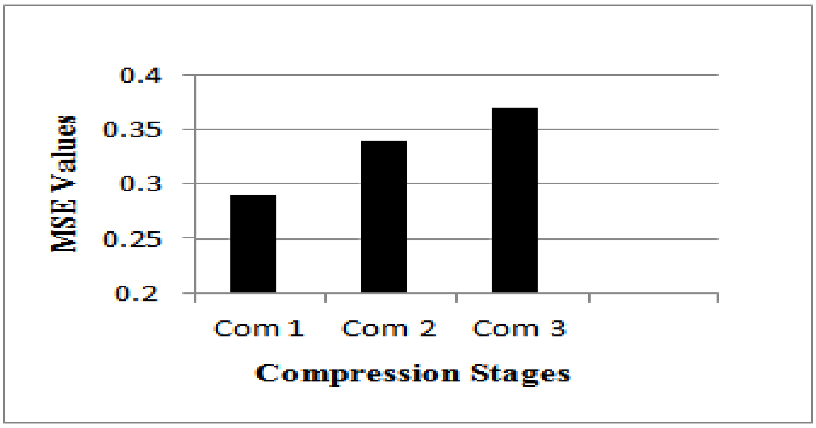

Figure 9: Analysis of MSE for the Flower Image.

Table1: Analysis for the Multi Compression

Compression Stage	PSNR	MSE	SSIM	Execution Time
1 STAGE	54.20	0.29	0.856	6.05
2 STAGE	59.13	0.34	0.843	1.67
3 STAGE	61.01	0.37	0.842	1.13

CONCLUSIONS

This paper explains a novel DCT architecture for image processing applications. When the image is compressed multiple times the quality of the image is not deviated from the original image. The quality of the image is estimated by evaluating the PSNR, MSE and SSIM values of the image. The efficiency of the image is estimated by measuring the execution time of the DCT algorithm. When the DCT algorithm is used the quality of the image while applying compression techniques is good compare to other algorithms. Hence the DCT and IDCT algorithm is used. The power estimation of the DCT architecture is evaluated by Xilinx ISE 8.1i. The power estimation of DCT architecture for the initial level is obtained by a row parallel 8×8 2D- architecture. Thus the power evaluation is obtained by this architecture.

FUTURE ENHANCEMENT

We have implemented the compression in a fixed number of times in a novel DCT architecture. We hope that in future it will automatically terminate the compression when the similarity deviation is high. The power analysis report is taken from the Xilinx ISE 8.1i by using place and root report for the initial level. We hope that it will take for the various levels of input levels of DCT architecture.

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