Hardware of watermarking Based on DCT

Tej R. Joshi
Electronics & communication, Marwadi education foundation & group of institutions
Gujarat technological university
Rajkot, India

***Abstract*----In this report Discrete Cosine Transform (DCT) compression technique is used for Watermarking of an image.DCT is the lossy type of compression technique. The main aim of the paper is to use the better algorithm for compression among all Algorithms because it is suitable for all types of images. Moreover,a balanced compression ratio for data compression and image quality by compressing the vital parts of the image with high quality.Coding of DCT in MATLAB is done and after coding in MATLAB the interfacing in Xilinx through VHDL. It should be noted that image can also be loaded directly into FPGA. Coding in VHDL is done and Hardware implementation by interfacing the code which is in the PC (VHDL) software to Spartan 3 kit.So here we have used VHDL language and FPGA for our hardware implementation seeing the advantages in speed and memory of parallel processor.**

I.INTRODUCTION

Objectives

- Get the basics of Discrete Cosine Transform and watermarking.
- MATLAB coding of DCT.
- Interfacing MATLAB and Xilinx through Simulink and loading directly an image in FPGA
- Coding in VHDL
- Hardware implementation by interfacing the code which is in the PC(VHDL) software to Spartan 3 kit. And viewing the result.
- Improvise those results as per our needs and make sure that this paper will be useful in real time applications.

Basics of Watermarking

- A kind of marker embedded in a noise-tolerant signal such as audio or image data.
- Typically used to identify the ownership or copyright of such signal.
- Process of hiding digital information on a carrier signal.
- It should be noted that hidden information does not need to contain a relation to the carrier signal.

Requirements of Watermarking

- We can digitally sign our photos or work or graphics or artwork.
- We can build our company brand , by having our company logo.
- Avoid the conflicts with plagiarists who claim they didn't know that you created it.
- Avoid the costly litigation.
- Avoid the intellectual property squabbles.

Types of Watermarking

- There are two types of watermarking:
  -visible watermarking and
  -invisible watermarking

VISIBLE WATERMARKING	INVISIBLE WATERMARKING
When we superimpose our logo or signature onto our image its called visible watermarking.	Hidden throughout the picture within the code that generates it. It is called invisible watermarking. It is recognizable pattern.
Less expensive.	More expensive.
It maintains the quality of picture	It reduces the quality of picture.
It is copyrighted. so cant be copied.	It is not copyrighted. so can be copied.

Embedding of Watermarking

- Embedding means hiding the data.
- Spread spectrum(SS) and the quantization are two most important techniques of embedding the digital watermark.
- Watermark embedding algorithm uses symmetric key or public key to embed watermark into original carrier information and then gets secret carrier. Watermark picking up/inspection algorithm uses corresponding key to inspect or recover watermark from secret carrier, without decryption key ,attackers difficultly find and revise watermark from secret carrier. The watermark is composed of many models, such as random digital sequence, digital identification, text and image, etc.
- Here the watermarking embedding model is shown below:

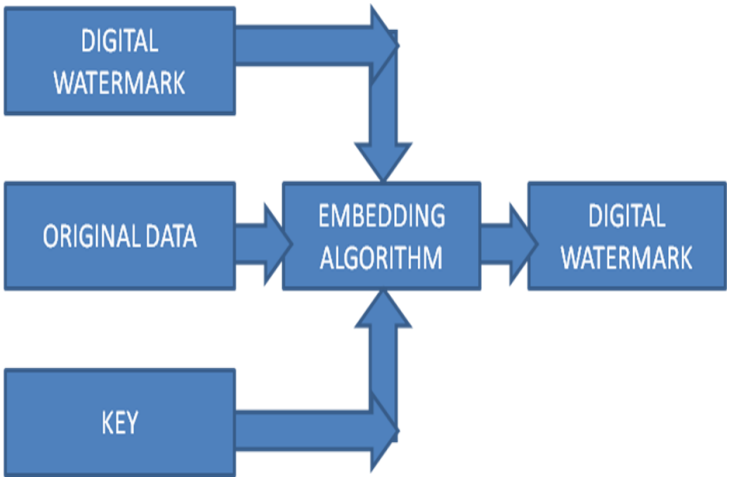

Figure 1 Watermarking Embedding Process Model

II.BASICS OF DCT

Compression Techniques and DCT

There are two main categories of compression: lossy and lossless compression.The examples of compression techniques are:

- Dictionary base encoding
- Run length encoding
- LZW encoding
- Huffman coding
- Statistical coding
- Arithmetic coding

Mentioned above are the examples of loseless compression techniques.

- Improved Grey Scale quantization(IGS)
- ***Discrete Cosine Transform(DCT)***
- Predictive coding or DPCM
- Discrete Fourier Transform(DFT)

Mentioned above are the techniques of lossy compression

- JPEG is widely used in process of compression that centers about discrete cosine transform.
- DCT works on separating image into different frequencies. During a step called quantization; the compression actually occurs.
- The less important frequencies are discarded, hence it is lossy compression and most Important frequencies are used to retrieve the image.
- As a result, the reconstructed image contains some distortion; but this distortion can be adjusted at the stage of compression.

How DCT Is Better Than Other Algorithms of Compression

- Makes a balanced compression ratio for data compression and image quality by compressing the vital parts of the image with high quality.
- Suitable and effective for all types of images i.e. in terms of resolution.
- Smoothness of image is maintained throughout the compression.

- Main purpose is compression, so *Cosine* terms are much more efficient for compression than *Sine* terms.
- DCT provides more compactness than DFT.
- It means a large amount of information is stored in relatively lesser no. of bits in DCT compare to other transform coding techniques.

How DCT Is Performed/Process Of DCT

The steps of DCT process are given below:

- The image is broken into 8*8 pixels.
- Working from left to right and top to bottom the DCT is applied to each block
- Each block is compressed by quantization.
- This array of compressed blocks makes an image that is stored in drastically reduced amount of space.
- When needed, the original image is reconstructed by decompression, a process that uses inverse discrete cosine transform (IDCT).
- The DCT equation computes the i, j th entry of the DCT of given image:

$$D(i,j)=\left(\frac{1}{\sqrt{N}}\right)C(i)C(j)\sum_{x=0}^{N=1}\sum_{y=0}^{N=1}p(x,y)\ \text{Cos}\Pi\left[\frac{(2x+1)}{2N}i\right]\text{Cos}\Pi\left[\frac{(2y+1)}{2N}j\right]$$

$$\text{Where, } C(u)=\begin{cases}\frac{1}{\sqrt{2}} & \text{If } u>0\\ 1 & \text{If } u=0\end{cases}$$

$$\left[\frac{(2x+1)}{2N}i\right]\qquad\left[\frac{(2y+1)}{2N}j\right]$$

➢ p(x, y) is the x , y th element of the image represented by the matrix p. And N is the size of the block on that DCT is done on.

- For the JPEG compression technique, the typical block size would be 8*8.
- So N=8 and (x,y) ranges from 0 to 7.

$$D(i,j)=\left(\frac{1}{4}\right)C(i)C(j)\sum_{x=0}^{7}\sum_{y=0}^{7}p(x,y)\ \text{Cos}\Pi\left[\frac{(2x+1)i}{16}\right]\text{Cos}\Pi\left[\frac{(2y+1)j}{16}\right]$$

A remarkable and highly useful feature of JPEG process is that during the *Quantization* phase varying levels and quality of image are obtainable through selection of specific quantization matrices.

- This enables user to decides the quality levels ranging from 1 to 100,where level 1 gives the poorest image quality and highest compression; whereas level 100 gives the highest image quality and lowest compression.
- If however,another quality level of quantization is needed,scalar multiplies of JPEG standard quantization matrix is used.
- If quality level is greater than 50(higher image quality,lower compression), the standard quantization matrix is multiplied by **(100-quality level)/50**.
- If quality level is less than 50(higher cpmpression,lower image quality),the standard quantization matrix is multiplied by **50/quality level**.
- Here, some images are shown with different quality levels in the below figures:

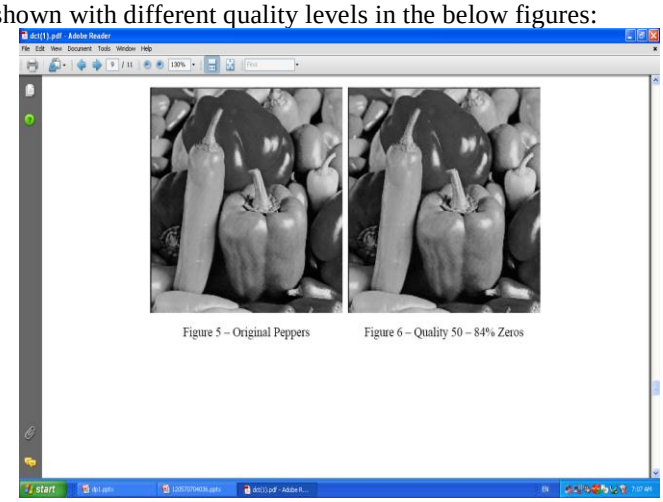

Figure 2 Comparison Of Original Image And Quantized Image At Level 50.

- It should be noted that with a quality level of 50,the DCT matrix renders both high quality and excellent decompressed image quality.

Figure 3 Images with Quality Levels Of 20 And Quality Level Of 10 Respectively

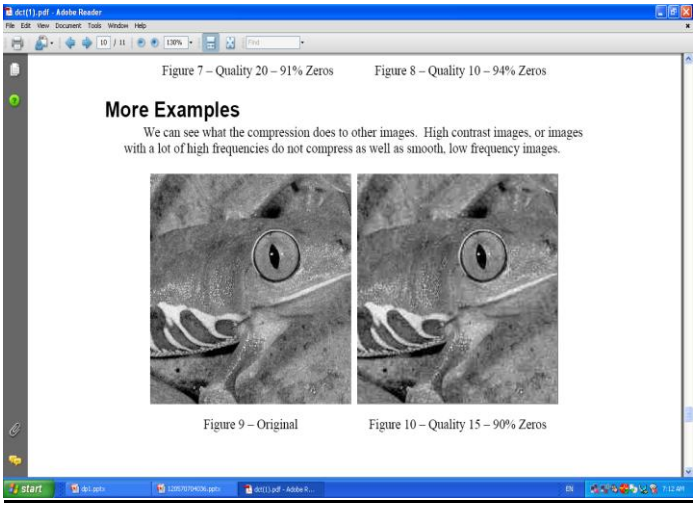

Figure 4 Comparisons of Original Image And Image With Quality Level Of 15(90% Zeros).

III.HARDWARE PART (SIMULINK THROUGH FPGA)

- Studied basics of watermarking and its requirements.
- Studied basics of Discrete Cosine Transform and how it is better than other compression techniques.
- How compression is done by DCT.
- Coding of DCT in MATLAB.
- Prepared general purpose diagram of Xilinx (a software for simulation).

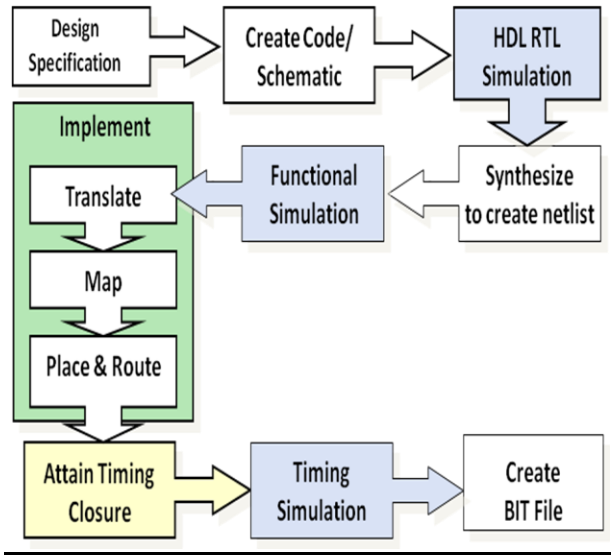

Figure 5 General purpose diagram of Xilinx ISE software which is used for simulation purpose in VHDL

IV.CONCLUSIONS

I have studied different algorithms for data compression and found DCT better among all to maintain quality and compression ratio of image for watermarking purpose. In future, I will implement this algorithm in hardware and make sure that it can be applied for real time applications.

REFERENCES

[1] McGowan, John. The discrete cosine transform. Web page http://www.rahul.net/jfm/dct.html
[2] W.N. lie, L.C. Chang "robust and high quality audio watermarking based on low frequency amplitude modification". IEEE trans multimedia, vol. 8 no. 1.
[3] http://lame.sourceforge.net/
[4] *IEEE Int. Conf. on Image Processing, 1996.*
[5] G. Caronni, "Assuring ownership rights for digital images," in *Proc.*
[6] *Reliable IT Systems, VIS'95, Vieweg Publishing Company, 1995.*
[7] K. Tanaka, Y. Nakamura, and K. Matsui, "Embedding secret information into a dithered multi-level image," in *Proc, 1990 IEEE Military Communications Conférence, pp. 216–220, 1990.*
[8] C. I. Podilchuk and W. Zeng, "Image-adaptive watermarking using visual models," *IEEE Trans. on Selected Areas of Communications* , vol. 16, no. 4, pp. 525–539, 1998.
[9] *Reliable IT Systems, VIS'95, Vieweg Publishing Company, 1995.*
[10] K. Tanaka, Y. Nakamura, and K. Matsui, "Embedding secret information into a dithered multi-level image," in *Proc, 1990 IEEE Military Communications Conférence, pp. 216–220, 1990.*
[11] C. I. Podilchuk and W. Zeng, "Image-adaptive watermarking using visual models," *IEEE Trans. on Selected*