A

DISSERTATION REPORT

on

Image Compression And Decompression In Terms Of Power And Area

by

Pramila Meena

2015PEB5117

under the supervision of

Dr. Lava Bhargava

Associate Professor, ECE Department MNIT,

Jaipur

Submitted in partial fulfillment of the requirements of the degree of

MASTER OF TECHNOLOGY

to the

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY, JAIPUR

JUNE- 2017

Department of Electronics and Communication Engineering
Malaviya National Institute of Technology, Jaipur

Certificate

This is to certify that this Dissertation report entitled "**Image Compression And Decompression In Terms Of Power And Area**" by **Pramila Meena** (**2015PEB5117**), is the work completed under my supervision and guidance, hence approved for submission in partial fulfillment for the award of degree of **Master Of Technology** in **EMBEDDED SYSTEMS** to the Department of Electronics and Communication Engineering, Malaviya National Institute of Technology, Jaipur in the academic session 2016-2017 for full time post graduation program of 2015-2017. The contents of this dissertation work, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

(Dr. Lava Bhargava)

Associate Professor, Dept. of E.C.E
MNIT,Jaipur

Declaration

I, hereby declare that the work which is being presented in this project entitled **"Image Compression And Decompression in Terms Of Power And Area** " in partial fulfillment of degree of Master of Technology in **Embedded Systems** is an authentic record of my own work carried out under the supervision and guidance of **Dr. Lava Bhargava** in Department of Electronics and Communication, Malaviya National Institute of Technology, Jaipur.

I am fully responsible for the matter embodied in this project in case of any discrepancy found in the project and the project has not been submitted for the award of any other degree. I also confirm that I have consulted the published work of others, the source is clearly attributed and I have acknowledged all main sources of help.

(Pramila Meena)

Acknowledgement

I am grateful to my supervisor Dr. Lava Bhargava for his constant guidance and encouragement and support to carry out this work. His excellent cooperation and suggestion provided me with an impetus to work and made the completion of work possible. He has been great source of inspiration to me, all through. I am very grateful to him for guiding me how to conduct research and how to clearly & effectively present the work done.

I would like to express my deepest sense of gratitude and humble regards to our Head of Department Prof. K. K. Sharma for giving encouragement in my endeavors and providing necessary facility in the Department. I am very thankful to Mr. Amit Joshi , PG Coordinator and all other faculty members of ECE, MNIT for their valuable assistance and advice.

I would like to thank Mr. Yogendra Gupta for timely help in this project work, I would also like to thank my friends for their support in discussions which proved valuable for me. I am indebted to my parents and family for their constant support, love, encouragement and sacrifices made by them so that I could grow up in a learning environment. Finally, I express my sincere thanks to all those who helped me directly or indirectly to successfully complete this work.

(Pramila Meena)

Abstract

Image compression is a technique of encoding an digital image, to reduce the number of bit which required for representing a image or send it using as fewer bits as possible. It purpose to save the storage space and transmission cost While maintaining good quality of image. Its solve the problem of storing large amount of data by the reduction in file size allows more images to be stored in a given amount of memory space. Image compression plays a critical role in telematics applications. The most common compression methods for images divided into two categories: Discrete Cosine Transform (DCT) based techniques and other based on wavelet transform technique. The Discrete Wavelet Transform (DWT) algorithm is well known and commonly used for data and image compression.

This thesis gives a brief description of image compression and decompression by using specified pixel value and performs Image compression as hidden layer and after decompression also achieved reconstructed image . I have used Matlab for input and output , discrete Wavelet Transform (DWT) for compression and decompression of image in verilog and synthesized using Xilinx. After analyzing the results, I have made some result and concluded my experiments. At the end report summarizes the finished work and gives some more developing directions of image compression and decompression.

Content

List of Figures

List of Table

Chapter 1

Introduction

1.1 Introduction:

Image compression is the application of systematic coding a digital image. It is used for reducing the number of bits which required for representing a digital image. Two factor storage and transmission cost which mainly required for maintaining good quality an image are reduce by using it . Image size and resolution both continuously increases by devices for developing of higher quality and less expensive image. By using less number of bits in this process for representing an image, Data storage space and communication cost also decrease. Decreasing the memory space requirement for an image is inversely proportional to the ability of storage medium and transmission bandwidth. Although storage capacity and transfer bandwidth has increases day by day, so that many applications require for compression.

Day by day many compression techniques would be developed for a image, which more effectively based on design challenges like as future communication system and advanced multimedia application. Pixel values of an image contain the information of that image and this information is the part of data that might be save in original form so that we could obtain original image after decompression. Means is that information and redundancy is that part of data. These two factor can be remove form the image when we have no requirements of those in image compression or can be again added these two factor in inverse process when we needed for reconstruct original image. For generate the original data in its original form then reinserted the redundancy.

For reducing the redundancy in data a technique is used. which is defined as Data compression. Data compression is a process in which some amount of information is remove form original image which is not useful for us and information is removed is known as redundancy. Its inverse process is known as data decompression in which remove redundancy is again added for achieve the original data. Image compression can be classified as lossless or lossy image compression.

This thesis gives idea of image compression which require in many application in these days. I have done my work on matlab and Xilinx ,achieve compression ratio ,area saving and power saving. Matlab use for input and output showing.

1.2 Motivation

Algorithms which is used for digital image compression algorithms exploit the redundancy in an image. So that a image can be represent using a less number of bits while maintaining original quality of an image. Some factors which mainly needed for image compression these are:

1. For increasing the storage of data.
2. Some low power devices which have small storage capacity.
3. Transmission bandwidth is also increase by it.
4. Computational complexity in practical implementation and time period also affected by it.

while progressing in image compression research offers various solutions to reduce storage space based on different techniques. These techniques are predictive coding, transform coding, block truncation coding, subband coding and hierarchical coding. Wavelet-based compression is a compression that allows the compression parameters to be changed at the time of decoding. This is also known as rate scalability, which used for decoding a compressed sequence at deferent rates. The transmission of compressed data between different devices Rate scalability used .

The challenges faced in image and video compression research are not limited to absolute storage and bandwidth concerns. In coding and decoding an acceptable level of computational complexity is also important for practical applications.

1.3 Problem Statement:

This thesis gives a brief idea of image compression and decompression. While using the algorithm some problem I have faced. I perform the image compression on pixel value which contains 255. If we take a image which have more brightness then properly perform compression and decompression on that image without any problem but if in case taking image have low brightness or image taken by mobile phone which is not bright then some problem arise. This problem is achieve due to these image not have more 255 pixel values for compression and while using discrete wavelet transform filter some information already lost.

1.4 Thesis Organization:

This thesis contains six Chapters :

- Chapter 1 : Introduction
- Chapter 2 : Overview of Image Compression System
- Chapter 3 : Discrete Wavete Transform
- Chapter 4 : Implementation of Image Compression using Matlab and Xilinx
- Chapter 5 : Simulation Result
- Chapter 6 : Conclusion And Future work

Chpter 1 gives the introduction and flow of thesis. Chapter 2 gives a brief introduction of image compression system, its uses and type of compression. Advantage of compression and also define its disadvantage. Chapter 3.Explain brief idea of Discrete wavelet transform and its uses in image processing. Chapter 4. Implementation of image compression and decompression matlab and Xilinx. Chapter 5 discusses the experimental results and analysis. Future direction and the conclusion of this work is discussed in Chapter 6.

Chapter 2

Overview of Image Compression System

Image compression is a process by which compresses the data which is required for image. Requirements of image compression increasing day by day, because continuously increasing communication process. For transmitting the image by mobile or computer then compression process is required because if the size of image is large is contain large transmission bandwidth by which transmission cost also increase. It is also very important in digital image processing for efficiently transmission of image and in terms storage also. For finding the image compression which we need to evaluate total number of pixel value which is in form of bits. These numbers of bits per image obtain by using typical sampling rates and quantization methods. Therefore evolutions of well planned compression techniques have become necessary. This thesis gives information about lossless image compression using Discrete wavelet Transform. It includes JPEG compression and describes all the components of it.

Information and redundancy are parts of data, data always represent in terms. In compression system we wants recover the original data during the compression and decompression process , we needed that the information which is the essential part of data that must be permanently save in its original form. Redundancy is also a part of data which can be removed and added in when we required of it. For generate the original data in its original form then reinserted the redundancy.

2.1 Classification Of Compression :

For understanding the method of data compression, we assume a input data D for compression ,after compression it contain less data as compare to original data D. For representation of it less number of bits are required which represent as c(D) and reverse process of it known as decompression. In decompression process use the compressed data c(D) and recover the original data D’. Sometimes compression system and decompression system known as coding and decoding. That’s why it is called a “CODEC”.

Data achieve after decompression (recover data D) could be identical to original data D or it could be approximated to original data D , it depends on the reconstruction requirements.

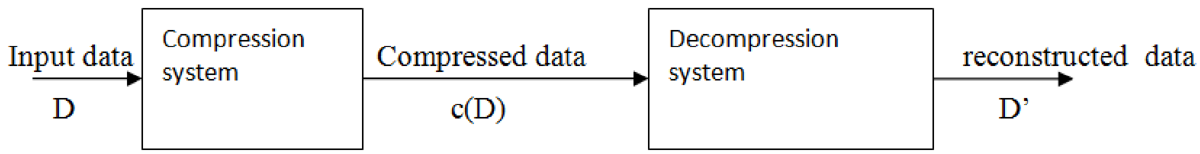

Figure 2.1:- CODEC

When both data original data D and recover data D’ are similar to each other it means that the algorithm used for compression and decompression process is lossless. On the other hand , if the reconstructed data D’is not same as original data , the algorithms used for compression and decompression are lossy. For reconstruct the original data after the decompression process on this bases the compression algorithms can be divided into two categories – lossless compression and lossy compression.

Lossless data compression techniques are mostly used for scientific or text data. It is mainly use in medical application .For data compression sometimes is introduce as coding, lossless and lossy compression technique respectively refer two terms noiseless and noisy coding. In lossy compression technique image obtain after decompression is not similar to input or original image that’s by the term “noise” here is in form the “error of reconstruction”.

Sometimes method of Data compression could be static or dynamic. Static methods of data compression is that in which mapping set of messages (data or signal) and compressed codes always fixed .In this process mapping set of signals is corresponding to the compressed code. In dynamic methods of data compression is that in which both are changed over the time period. A dynamic method is also known as flexible. In which codes modify so that characteristic are changeover the time period.

For example, if the probabilities of occurrence of symbols from source are not fixed over time , binary codeword of the symbol is suitable in form of an adaptive formulation ,for better compression efficiency ,then the size of compress file elastic change.

We can achieve compression by removing various types of redundancies which might be present in the pixel values of an image. Mainly theses three type of redundancies present in digital image are:

2.1.1 Psycho-visual Redundancy:

This type of redundancy exists in human eyes because it does not ability to see each pixel quantization analysis or its luminance value in the image. So that eliminating some less relative important information which is not essential for normal visual processing.

2.1.2 Inter-Pixel Redundancy:

Inter –pixel redundancy has two types:

1. Inter-pixel Spatial Redundancy:
2. Inter-pixel Temporal Redundancy:

2.1.2.1 Inter-Pixel Spatial Redundancy:

Interpixel redundancy is corresponding to the correlation between the adjacent pixels in an image. Adjacent pixels are not inertly independent to each other due to the gray levels are not uniformly distributed. In an image neighboring pixel are highly correlated by which vale of given pixel can be predicated .every individual pixel carry relatively small information .In this type of redundancy difference from one pixel to the next pixel values is use for representing a image.

2.1.2.2 Inter- Pixel Temporal Redundancy:

Interpixel temporal redundancy is statistical dependent. In this type of redundancy adjacent pixel are statistical correlated from successive frames in video sequence. It is also known as interframe redundancy. we could achieve efficient video compression removing a large amount of redundancy .

2.1.3 Coding Redundancy:

It is corresponding with the uncompressed image in which each pixel coded by a fixed length .We say that in which data is symbolized in the terms of codes. An image in which for representing the gray levels of that image use more code symbol which is not necessary for represent the these gray level. Then we say that the resulting image contain this type of redundancy.

2.2 Compression Methods:

Different type of compression techniques used for compression of images. So that after compression it contain low storage space and transmission cost also low. Compression method can be divided into two ways:

1. lossy compression
2. lossless compression

2.2.1 Lossy Compression Method:

A lossy compression technique mainly used where we can remove some information of image for achieving the high storage space and more bandwidth. In Lossy compression we colud obtain higher compression ratio, because in this method we could compress the data in larger amount by some amount of information loss. But in lossy compression we cannot completely recover the original data.

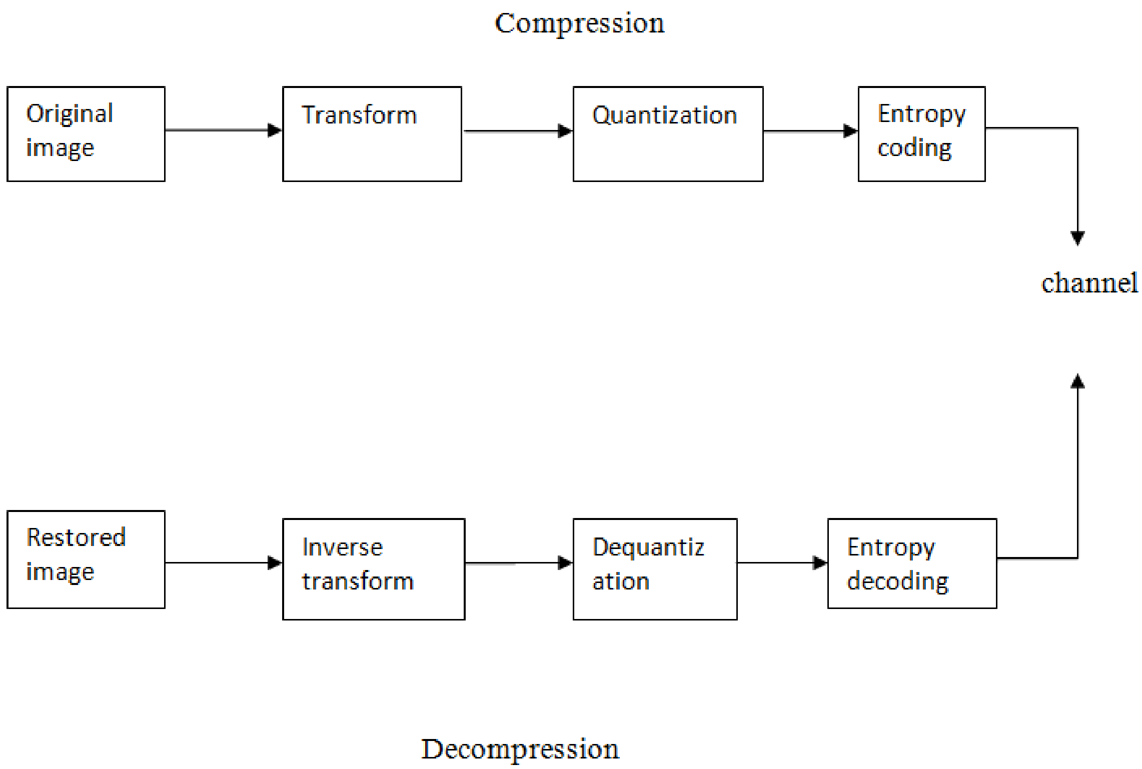

Figure 2.2:- Block Diagram for Lossy Image Compression

In this method first step is that transform the image and after that systematically remove the inter-pixel redundancy from the data. After that it is applied on quantizer which remove psycho-visual redundancy. So that we can represent the packed information with less number of bits as possible. By using entropy encoder we can achieve the high compression ratio by encoded the quantizes bit effectively. Three components mainly used in lossy compression system. Which are three types:

1) Source Encoder
2) Quantizer
3) Entropy Encoder

2.2.2 Lossless Compression Method:

Lossless Compression method is that in which eliminate the number of bits during the compression process without any degradation the original quality of the image. In lossless compression image achieved after decompression same as original image. No information loss in lossless compression. In this compression technique we can efficiently reconstructed the original data. But in this process low compression ration achive because no information loss .Compression ratio in this process is around to 2:1. This compression technique mainly has been a required In medical applications, because it provide the accurate diagnosis in medical field without any loss in the original image.

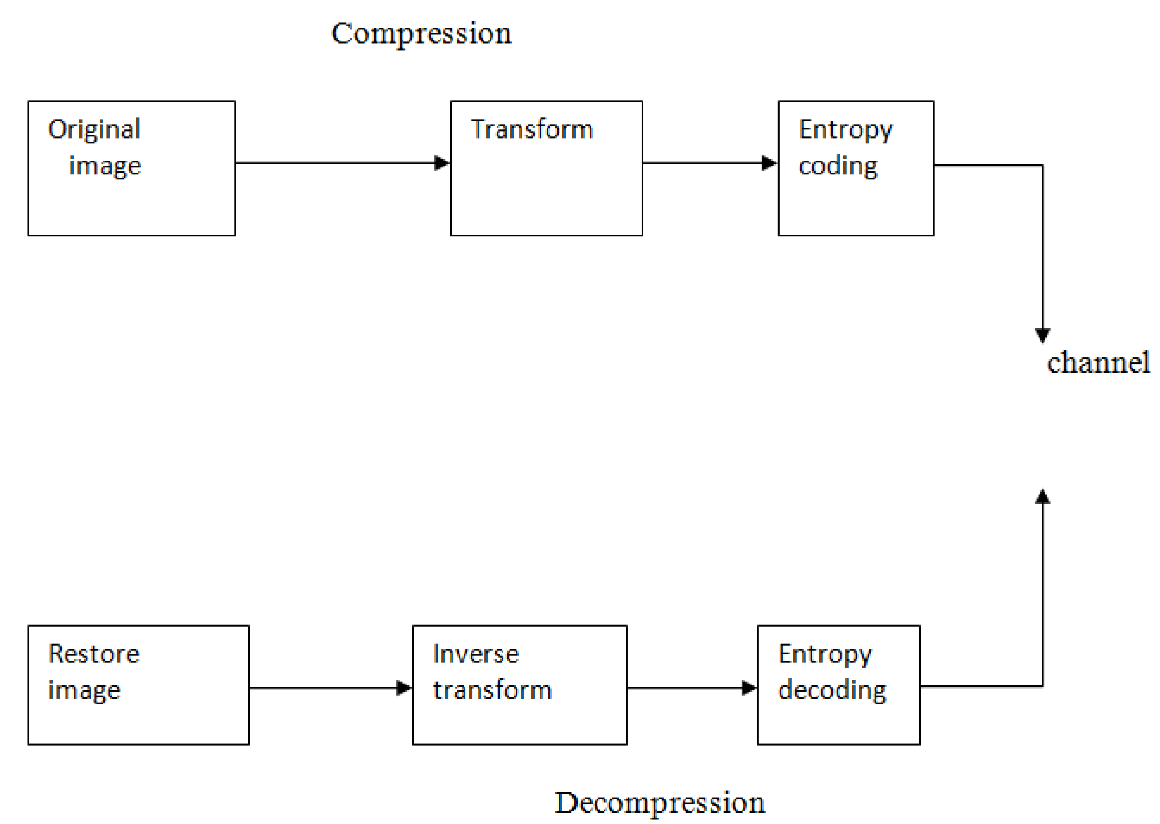

Figure 2.3:- Block Diagram for Lossless Compression model

A lossless compressor process mainly contain two level. First step is that in which input image convert in some other format so that we can eliminate inter-pixel redundancy from it.

Second level of it contains the entropy encoder for eliminate the coding redundancy from it. Lossless decompression and the lossless compression are exact inverse process to each other.

2.3 Predictive coding:

In this method test image and the values of each pixel reconstructed image are similar to each other. So that this method is known as lossless coding method and in this method use Differential Pulse Code Modulation (DPCM).

2.4 Transform coding:

It is an fundamental part of compression process. In transform coding use reversible linear transform .It is used for matching resultant coefficient which are quantized and encoded and the image which is a set of coefficients.

2.5 A Data Compression Model:

A data compression model basically has three level. First step is that eliminate or remove data redundancy. Second step is that reduction in entropy and third step is that entropy encoding. In different types of redundancy may present . It might be introduce in various format. An image the adjacent pixel are correlated to each other. Means of correlation is that, pixel value of the non –edge smooth regions are very similar. For formation of the words or sentences in a normal text proceed same context model .Which is based on the grammar being used.

Likewise, the minute entities that take in every record in database may have some short of relationship among them in numeric database. In any normal audio or data speach they are flow and stop on fixed intervals .For achieving expected compression , these types of redundancies should be reduce in data representation. If we convert the input data from one form to another form and represent it in another form, then we obtain data redundancy. If convert the input data from spatial domain by using the DCT (discrete cosine transform) and decay of the input data set into various sub-bands by using the DWT(Discrete wavelet transform).According to the concept, representation of information more compact in input data set in form of less coefficients or equivalents. This process is entirely inverse in case of lossless data compression.

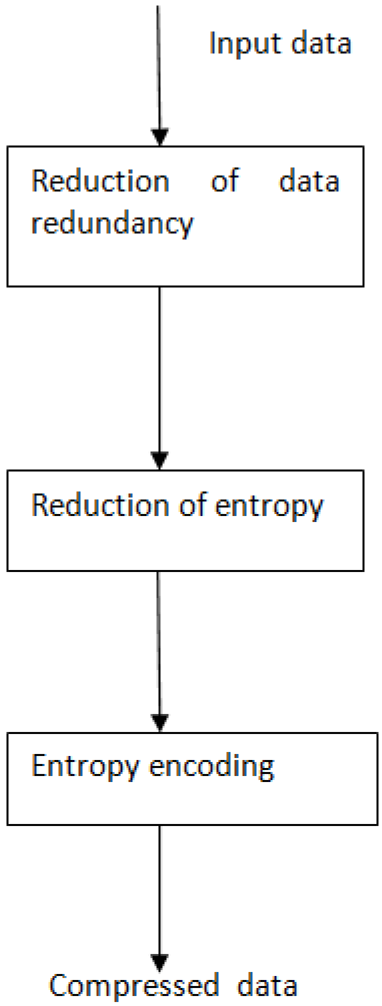

Figure 2.4:- A Data Compression Model

In lossy compression system major step is that remove the entropy of convert data so that provide less bits for transmission and storage. In this compression process some amount of information has lost so that it is known as lossy compression. Image which is reconstructed after decompression is not exactly same the input or test image. In inverse we can not reconstructed the lost data or information.

This is generally established by using several version of quantization process. After that the quality of reconstructed data prescribes by the nature and amount of quantization. In lossless encoding ,the quantization coefficient used various entropy scheme to completely show the quantized data for memory and transmission. As compared to the original one the entropy of quantized element is less. It is also represent by fewer bit as compared to original data set, by this way compression is achieved. Just inverse process used in decomposition system .For generating the quantization coefficients firstly decoded the compressed code.

On these quantized coefficients applied the inverse quantization process to produce the approximation of the converted coefficients. For the generation of original data quantized transformed coefficients are inverse transformed. If both quantization and inverse quantization steps are not present in it and the step for redundancy elimination is inverse, then the output produce after decompression is similar as input data, this type of compression model is known as lossless compression model.

2.6 Advantage Of Data Compression :

1) By using it faster transmission time and reduce transmission cost.
2) Reduce the data storage requirements.
3) Rate of reading and writing (input and output) in computing device increase greatly due to shorter representation of data.
4) File transfer faster.
5) Variable in form of dynamic range and byte order are independent.

2.7 Disadvantage Of Data Compression :

1) If both the transmitting and receiving modems support the same compression procedure then compression can be used.
2) In both coding and decoding process extra overhead appear is one of the most serious drawbacks.
3) The reliability of the records also reduce by data compression.
4) While transmission of compressed data through a noisy communication channel is risky because it introduced the brust errors.
5) If degreed the properties of a compressed data it means that compressed data defer from the input data because interruption of data properties of compressed data.

2.8 Literature Review:

This thesis presents a framework for an image processing based discrete wavelet transform(DWT) system. I have done my work on a digital image by using discrete wavelet transform because it has some techniques like as transversal filter ,lifting scheme and codec etc. Discrete wavelet transform is a type of wavelet transform which used for discretely sampled. I have work on it in image processing because it has an advantage . It has temporal resolution over Fourier transform. It capture both frequency and time.

Discrete wavelet transform has lifting scheme technique which provide advantage like as low memory space and arithmetic implementation and computation. DWT also has multi resolution scheme for 2-D digital image. By applying DWT on two dimensional image it can be decompose into one level or two level. For perform the operation in image processing then DWT use for removing the noise from image and achieve the compression.

In chapter 1 , I have described image compression modal and types of image compression. In second chapter I have explain overview of image compression model and types of compression and also explain which type of compression mostly use in image processing and its application also. In chapter 3 I have explain how to DWT use in compression of an image and level of decomposition for image. In chapter 4 I explain the algorithm which is used for image compression. Chapter 5 consist the result of compression algorithm.

Discrete wavelet transform has most popularity because it has its outstanding de-correlation properties, discrete wavelet transform used as the transform stage in many morden image and video compression system .I have done my work on the JPEG2000 image coding utilize the 9/7 filter and 5/3 filter. 9/7 is a default filter which is used for lossy compression. In lossless compression mostly use 5/3 filter.For discrete wavelet transform (DWT) based image compression, it is widely allow.

The 9/7 filter among the based filters .By using the 9/7 filter the performance of a hardware implementation determine by the accuracy. Lossless image compression technique most widely use in field such as medical application ,remote sensing and preservation of artwork, etc. For digital image compression DWT becomes more public day- by- day .In the JPEG2000 codec standard (5,3) and (9,7) bi-orthogonal filter have chosen as a standard filter.

Discrete wavelet transforms (DWT) as reported by zervas , which have three format. For the two dimensional DWT these three architecture are level -by- level, line based and block based. For line based architectures, a recursive algorithm is used .First by the image to be transformed and store in a two dimensional array .Firstly we obtain all the element in a row, on the particular row convolution is performed .In the process row wise convolution a complete image divided into two parts. Each parts has equal row which is the half of that image.

After that perform a recursive line based convolution on this matrix .But this time perform column-wise convolution. Result obtain after that is the coefficient of discrete wavelet transform. Corresponding to that image ,the top left quarter of the matrix occupied by the approximation coefficient and the bottom –left quarter occupied by the horizontal coefficient ,top-right quarter of the matrix occupied by the vertical coefficient and the bottom-right quarter of it occupied by the diagonal coefficients.

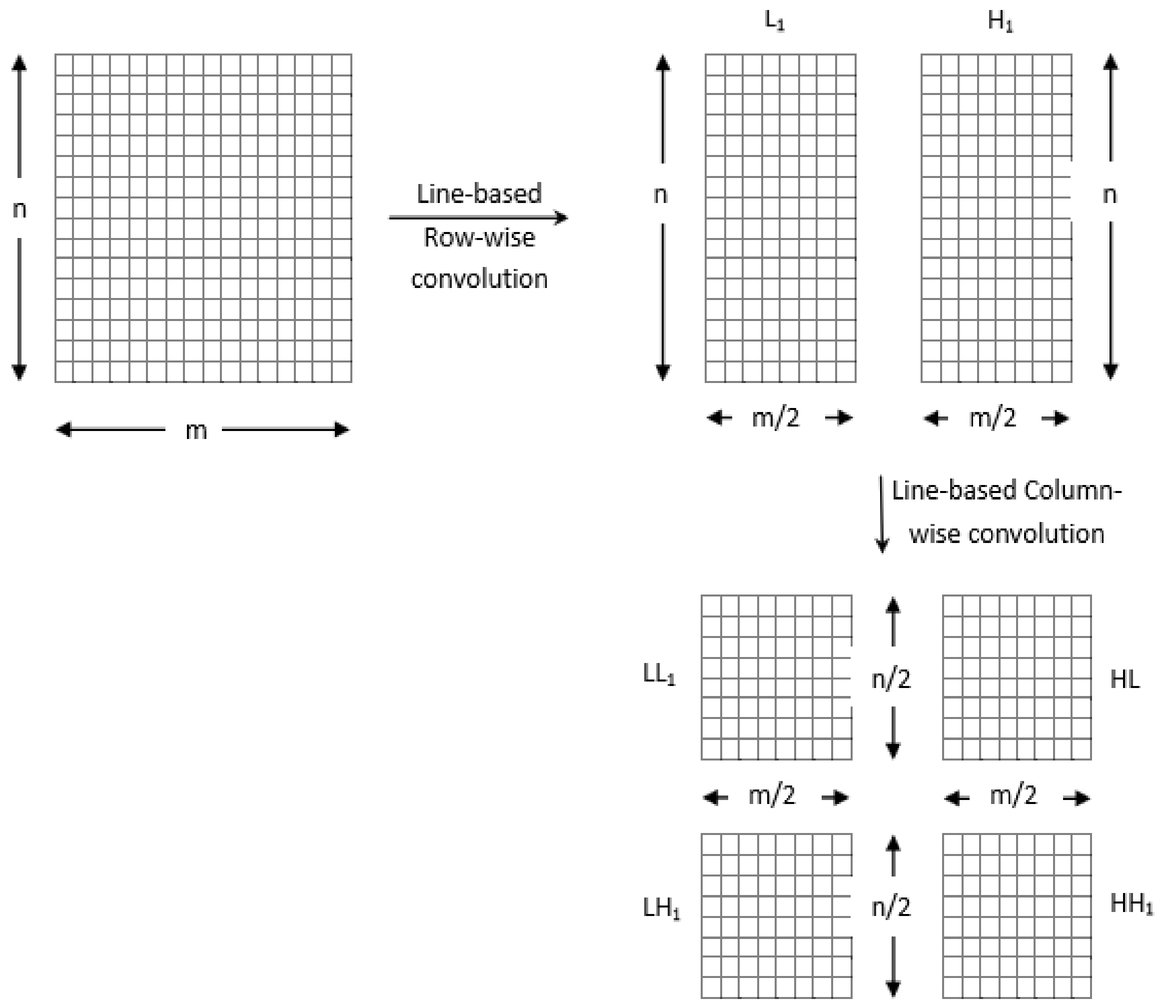

Figure 2.5:- 2-D DWT Line Based Architecture

After introducing DWT, for performing compression on the transform as much as possible, several codec algorithms were introduce. Among several algorithm I have use one algorithm and perform compression. In this thesis I have compute the result by using two software. For reading the image and show the reconstructed image after decompression use matlab. In matlab I also the compression ratio and power saving .After reading the file in matlab generate a hex file which read in Xilinx and perform compression on it .This file read in matlab for checking the number of values after compression. After that perform decompression on that file by using Xilinx and generate file read in again matlab for reconstruct the original image.

Chapter 3

Discrete Wavelet Transform

In an image compression the most popularly use method is wavelet transform. Wavelet is mathematical function. It is used for dividing the data into different frequency component and after that matched the resolution into the scale. For transform a signal into a series of wavelet transform is used. A single image can be store different parts of resolution in a wavelet. Image processing , which should be divided into many parts. For compress the image which contains less storage space and also contains full details of image wavelet is applicable. An image detain can be divided into approximate, horizontal, vertical and diagonal details.

A 'wave' represent in terms of mathematical. When it represent in mathematical format, then it can be show as sinusoidal function of time or space. A random signals expresses in form of infinite number of oscillating function its harmonics by the Fourier analysis. When a signal represents in terms of Fourier, then it is to be very effectively known as in analysis of time invariant (stationary) periodic signals.

A wavelet is a type of small wave. Whose energy is congregate in time, in variation to sinusoidal functions. When we analysis a signal at the same time in terms of both time and frequency then should be use wavelet properties, due to the fact that the energy of wavelet is congregate in time and still possesses. If a wave has characteristic occurring a time intervals (periodic), strongly enhance the picture quality at high compression ratio, wavelet based coding is use. It is prefer due to it has better energy squeeze property of wavelet transform.

If wavelets are achieve from a single prototype wavelet by enlargement and change the position or direction, called mother wavelet. If the wavelet transform is obtained individually form various segments of the time-domain signal at different frequency. Different type of transform use for coding are:

1) FT (Fourier Transform)
2) DCT (Discrete Cosine Transform)

3) DWT (Discrete Wavelet Transform)

3.1 Discrete Cosine Transform (DCT)

For divided an image into sections or sub-bands of differing with respect to visual characteristic of image helped by the discrete cosine transform. Discrete cosine transform is likewise as the discrete Fourier transform. It metamorphoses an image or a signal from spatial domain to the frequency domain.

3.2 Discrete Wavelet Transform (DWT)

Discrete wavelet transform is a modify method of numerical and functional analysis for an image. By using this wavelet transform wavelet are distinctly evaluated. It has an advantage over other types of wave transform. Over Fourier transform it has temporal resolution. It captures both frequency and time.

For discretely sampled of wavelets , wavelet transforms referred by the Discrete wavelet transform. Compared to the Fourier transform, a transform in which localized a function both in scope and scaling. It also has some advantageous characteristics. As compare to analogous Fourier matrix this transformation establish on a wavelet matrix in which computation formed too fast. In data compression where the discrete signal are represent in more redundant form by using the properties of transform where coding for the signal use the discrete wavelet transform. Discrete wavelet transforms use in many field like as in Engineering, Mathematics ,Science and computer science etc.

Wavelet compression is also a form data compression. Which is appropriate for compression of an image (sometime audio compression and video compression).Main objective of that store a image or data in small space as much as possible in memory. In lossy compression is accepted some information loss. Transient signal which are continuously change with time like as audio and higher frequency components in 2-D image, for compression of these signals wavelet transform is use. For example, stars image in which element are transient in nature.

3.3 DWT for Image Processing:

For represent the signal in dynamic DWT sub-band decomposition is used. Without the constraint of dynamic decomposition ,creation of the DWT in a wavelet packet admit sub-band analysis. Adaptive decomposition of frequency axis performed by the discrete wavelet transforms. According to optimization criterion, specific decomposition would be selected. For the time-scale representation DWT is used . It is also provide systematic multi resolution sub-band decomposition of signals.

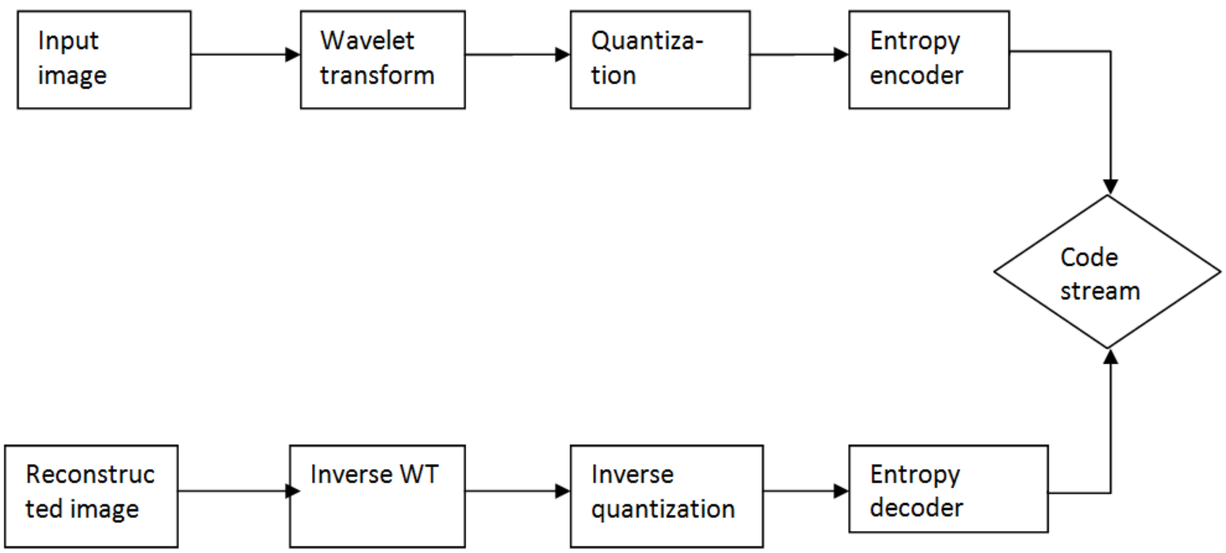

Figure 3.1:- Block Diagram For Image Processing

Firstly applied a wavelet transform on an image. By which it produce as many coefficient as there number of pixels in an image (it is only transform no compression yet perform).After that a few coefficient which contain statistically condense information ,these coefficient can be compressed more easily. This concept is known as transform coding. By using the entropy encoded or run length encoded , these coefficient are quantized.

For the signal processing it becomes a powerful tool. It finds in various numerous application area such as pattern recognition, audio compression, texture discrimination, computer graphics etc.

For the application in image and video coding 2-D DWT and its inverse form 2-D inverse DWT (IDWT) play a remarkable role. Size and quality of image data can be reduce by using this image processing , so that it can be stored in a small amount of memory. In this process the image is compressed and decompressed and the result has given at the output.

3.4 Extension to Two-Dimensional Signals:

Transformation of two-dimensional signal for a digital image is performed by essential using two-Dimensional extension of DWT. Two-dimensional signal array A[X, Y] where X and Y represents, X rows and Y columns, is use for representing two dimensional digital signals, where X and Y are nonnegative integers. Two dimensional implementation of the DWT simple approach is that firstly applied the one dimensional DWT row-wise to produce an intermediate result .After that same one-dimensional DWT again use for column-wise on this intermediate result to produce the final result. This is shown in figure 3.2.

Two-dimensional scaling function could be explain as independent function. Which is result of two-dimensional scaling function like as $\Theta 2$ p, q = $\Theta 1$ p $\Theta 1$ q. The same is realistic for the wavelet function $\psi(p, q)$ as well. The one-dimensional transform is applying on each row, by which two sub-bands are generate in every row. When all the rows (L) low frequency subbands are arranged ,then it looks like a narrow design (of size X x Y/ 2) of the input signal as shown in Figure.

In same manner the high-frequency sub-bands of all the rows put together then generate the H subband (of size X x Y/2),that contain mainly the high-frequency data around lack of continuities (edges in an image) in the input signal.

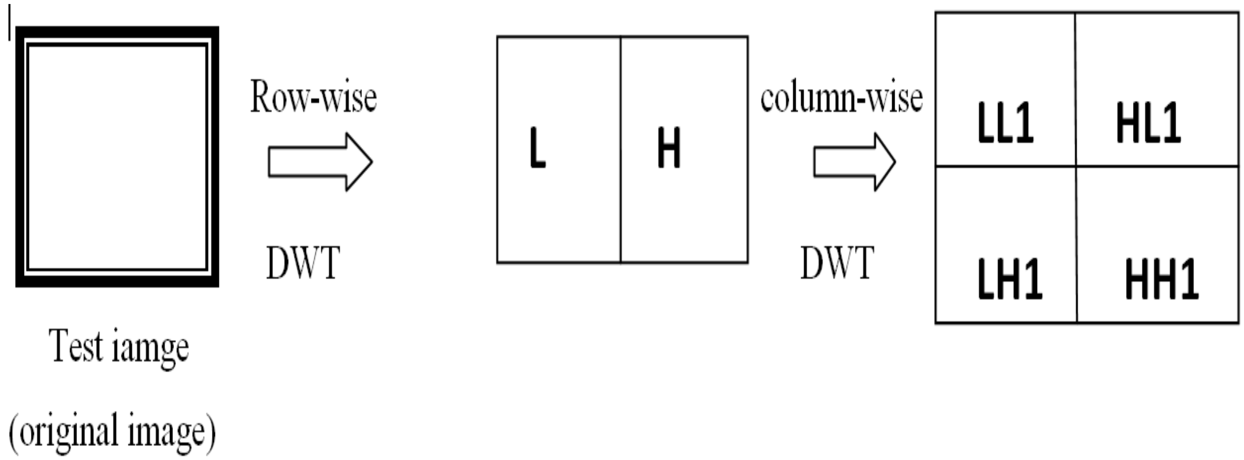

Figure 3.2 :- Using DWT first-level of decomposition

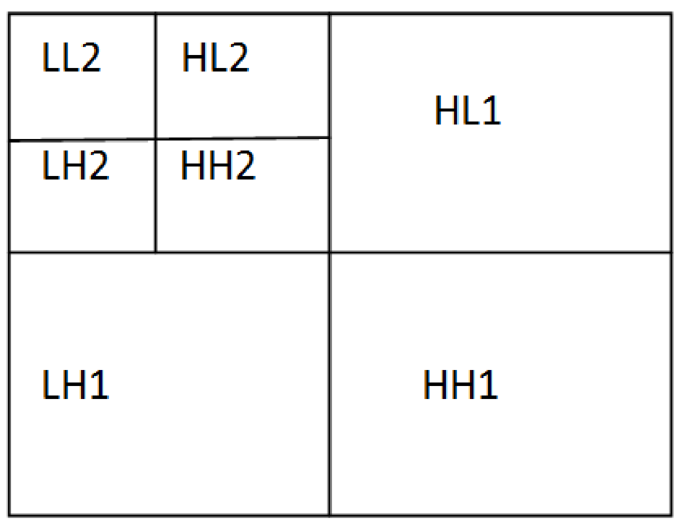

Figure 3.3:-Using DWT Second level of decomposition

After that using a one-dimensional DWT column-wise then these L and H sub-bands are obtain. These four sub-bands LL, LH, HL, and HH of size X/ 2 and Y/ 2 are create as shown in figure 3.2. LL is a exact same as of the original input signal contain main information of original signal. While the other three sub-bands are high frequency sub-bands which contain the detail information. If we put one-dimensional DWT vise-versa like as column-wise first and after that row-wise to obtain the same result by this process also.

In two-dimensional signal multiresolution decomposition approach is prove in figure . Figure3.2 shows four subbands LL1, LH1, HL1 and HH1 which are generate after the first level of decomposition. The LL1 sub-band can be observed as a 2:1 subsample (both horizontal and vertically) area of image. Three other sub-bands which have higher frequency detail information. These three sub-bands mainly contain information of local lack of continuities in image which place as (horizontal, vertical or diagonal).These three sub-bands contain lack of information of original image so that those are not useful of compression .These high frequency subbands are not useful for image compression.

LL1 is same or approximate of the original signal, it has same spatial and statistical characteristics to the original image. Result of it , again can be further decompose into four subbands like as LL2, LH2, HL2 and HH2 as shown in figure3.3 based on the fact of multiresolution analysis. For third level of decomposition result achieve from second level of decomposition applied one-dimensional DWT over it.

Chapter 4

Implementation of Image Compression using Matlab and Xilinx

A digital image is containing of a finite number of elements, each element in image has a particular position and value. Compression of a digital image is a complicated process and it involves numerical steps of calculation. After calculation we obtain the required number of bits which is used for represent a digital image. In image compression data redundancy is a elementary issue. For achieving higher compression ratio we use lossy image compression technique which provides a higher level of data reduction but in case result obtain is less than perfect reproduction of original image. Some amount of information loss in this compression process. I have done my work using lossless image compression technique in which no information lost and image obtain after decompression is similar to original image. I have used Discrete wavelet transform compression and decompression of an image.

4.1 Algorithm:

A digital image is 2D consisting of rows and column, in which rows and column is use for representing two dimensional digital signal , where value of rows and column are nonnegative integer .By apply discrete wavelet transform on image , the input image firstly reorganized either row or column wise .If the input image is first reorganized to column matrix by reading every 4 x 4 block of the input image to 16 x 1column elements.

By using 2D DWT the input image first decomposed into subbands and these subbands are rearranged in form of column element as shown in figure 1. Size of each input subband is K x K regrouped to N x N sub block, after that the N x N sub block is read row wise and is rearranged into column elements, every N x N block is rearranged form K x K sub-band and rearranged into N x N x M elements.

4.2 Compression and Decompression Algorithm in Verilog:

This algorithm implemented in verilog on 256 x 256 digital images. Steps of algorithm are:

Step1:- In this step firstly convert a colorful image into gray scale image.

Step2:- I have created a HEX file or COE file of a gray scale image using matlab which contain pixel values of the 256 x 256 digital images.

Step3:- I have using discrete wavelet transform (DWT) .In DWT I use symlet wavelet filter (sym4) on gray scale image. It derive four parameter for an image. This hex file contain total number of

Step4:- These four parameter are define as a, b, c, d in code, out of four parameter only 'a' parameter is same as original image(This concept I have already explain in chapter 3), which size 131 x 131 intensity of this low so that this image again convert in image(i) for brightness and size also resize in 132 x 132.

Step5:- I have used 4 x 4 sub block so that resize it in 132 x 132.Each block contain total 16 values. After this process it convert 33 x 33.

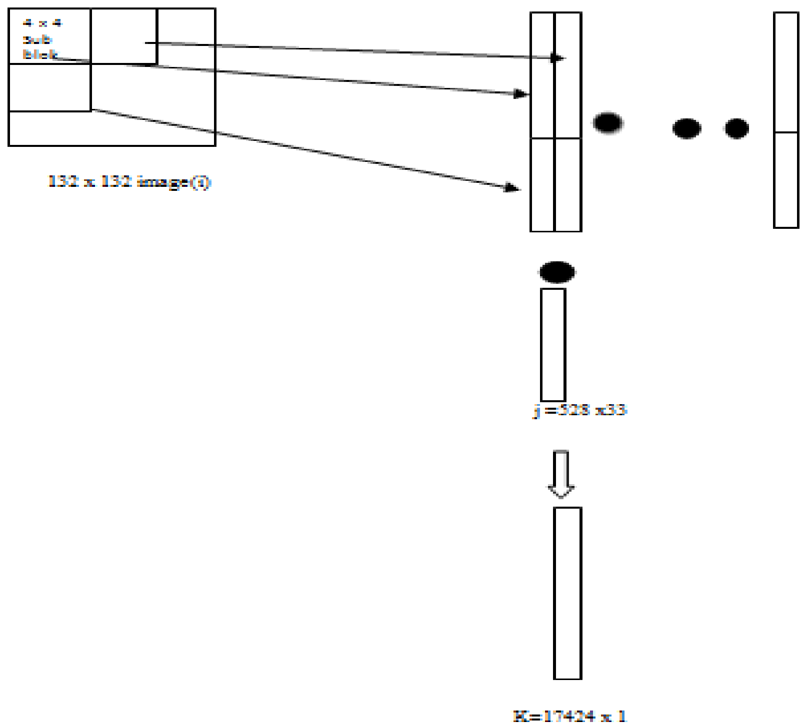

Figure 4.1:-Experimental Block Diagram of Compression

Step6:-Each block have 16 value and total no block in a column 33 than total value in a column is 528 , after that size of j 528 x 33. It again converts into a single column of size 17424 x 1.this file read in Xilinx.

Step7:-In a image pixel value range 0 to 255 . I perform compression method on those pixel which have value 255.(Example 1: if 255 repeated three times then it can be written as 255 in first row and 3 in next column which shows that 255 repeated 3 times in K table).This operation perform in Xilinx.

Step8:-Compress file read in matlab for read the number of values generated after compression, after that according to these values use in decompression code in Xilinx , for performing the decompression again.

Step9:-In decompression method, 255 value again write three time(according to example 1) in each column by this process total number of value equal to previous one. Decompression fallow the same step in inverse.

Step10:- Decompress file generated form Xilinx ,read in matlab for check the number of value same or not the original value after that show the decompressed image .Here I used Matlab for show the input and output image reading. In lossless compression both compress and decompress image same , no information loss.

4.3 Overview:-

In this chapter 4, we discussed about the implementation of the image compression algorithm. In section 4.1, we discussed about the compression and decompression algorithm and its implementation in Verilog by taking input from Matlab and show the output Matlab. Now in next chapter 5, we are going to discuss about the results obtained from those algorithm using verilog and matlab.

Chapter 5

Simulation Result

In the previous chapter, we have discussed the implementation of the algorithm image compression. This algorithm is implemented using two platform, first in matlab in which we firstly read a image for testing(or image we want to compress) either colorful or gray scale after reading this image we apply DWT on it. By which image divide into for sub bands, taking LL subband image compression perform. Hex file generate by matlab which read in Xilinx and compression perform on it. After that compress file generate by Xilinx ,this file read in Matlab for read number of values .If the number of values less than the previous Hex file, it means compression performed. Then according to this file values in decompression and by Xilinx ,perform the decompression of image. This file read in Matlab and shows the reconstructed image. Now in this chapter we are going to discuss the simulation result which was obtained from the compression and decompression algorithm using matlab and verilog.

5.1 Simulation Result of DWT in Matlab:

In this we will discuss about the results of compression and decompression.

5.1.1 Image 1:

Fig 5.1: Input image

Fig 5.2: After One level 2D-DWT decomposition

Fig 5.3: Reconstructed image after 2D-IDWT

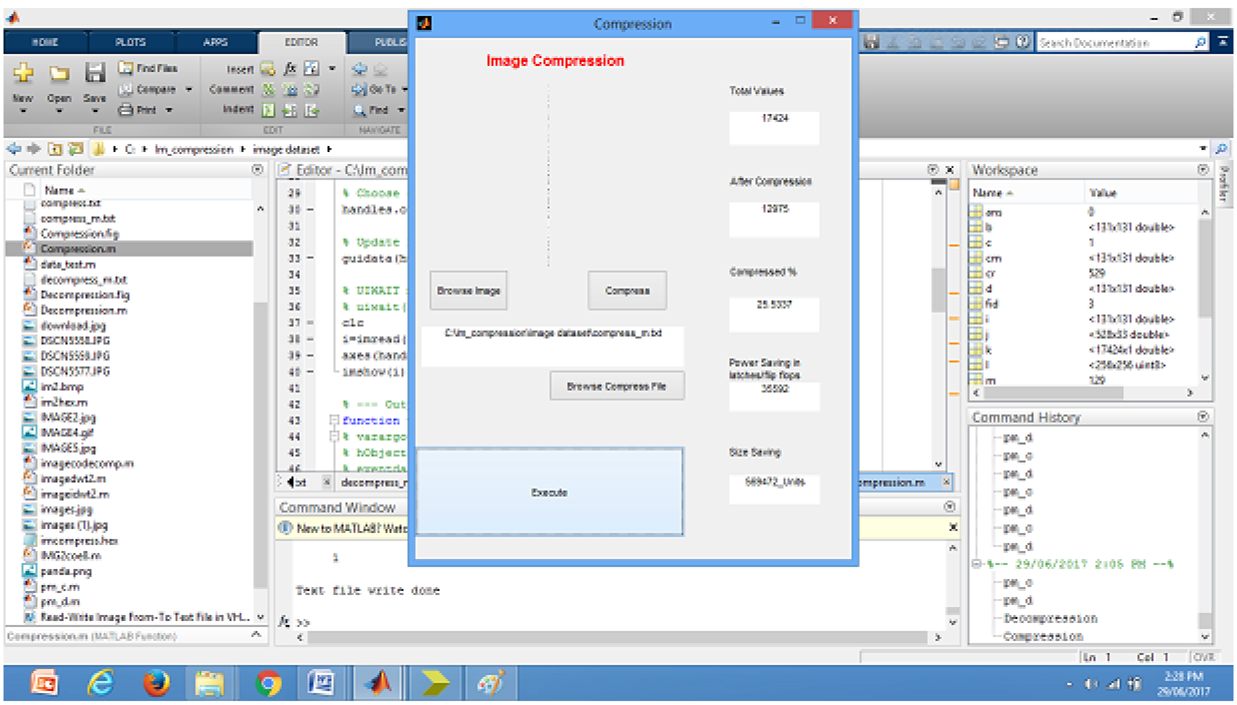

Fig 5.4: Result of Compression show in Matlab

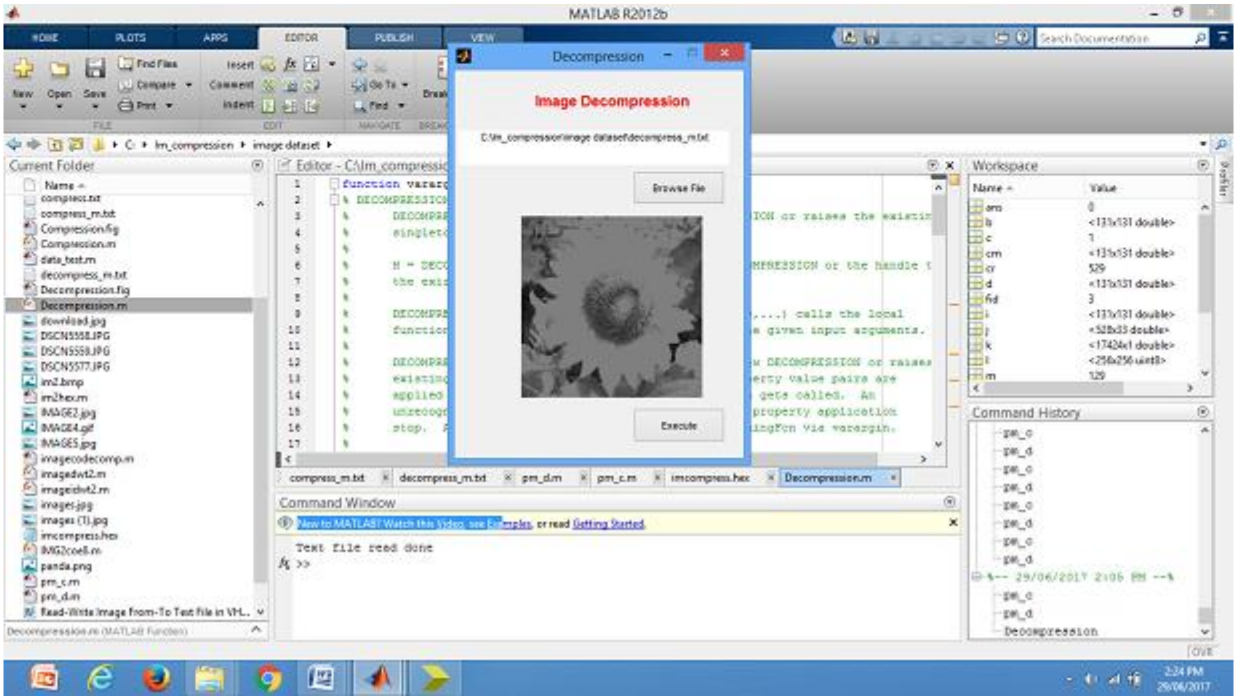

Fig 5.5: Result of decompression show in matlab

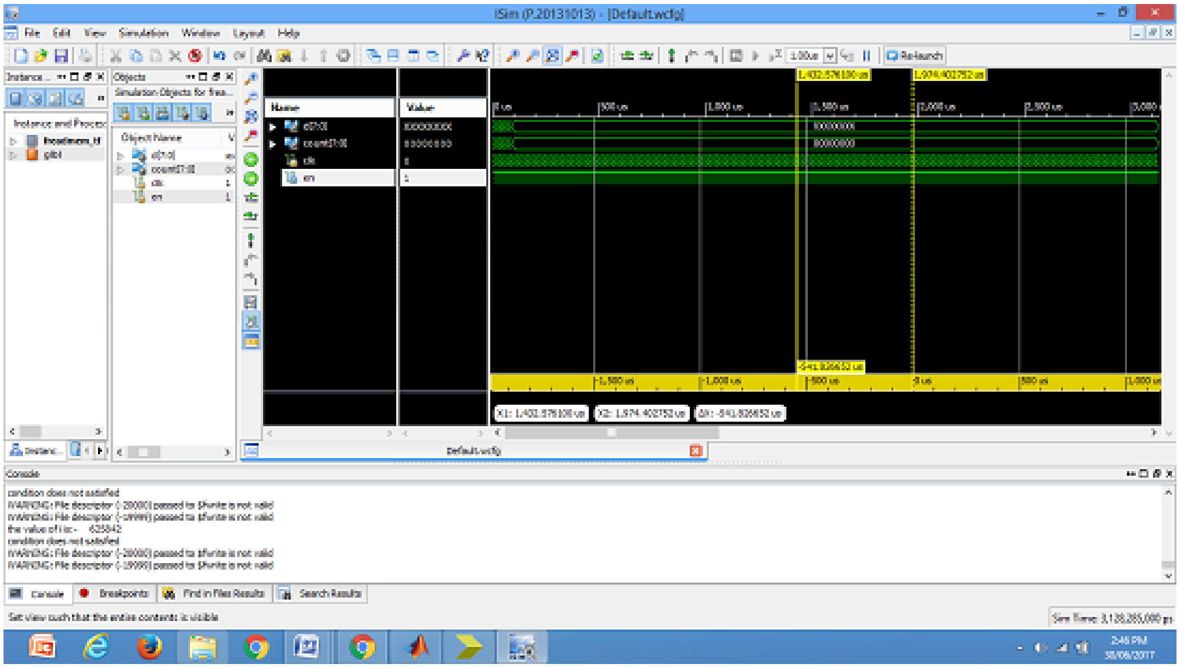

Fig 5.6: Output waveform for compression in verilog

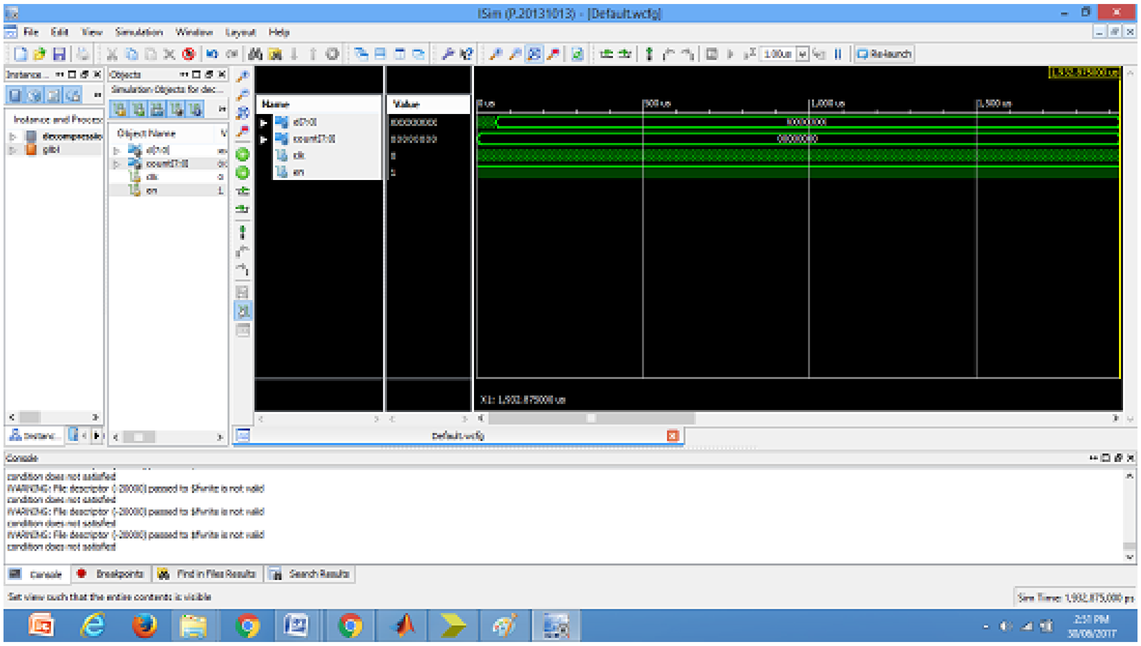

Fig 5.7: Output waveform for decompression in verilog

5.1.2 Image 2:

Fig 5.8: Input image

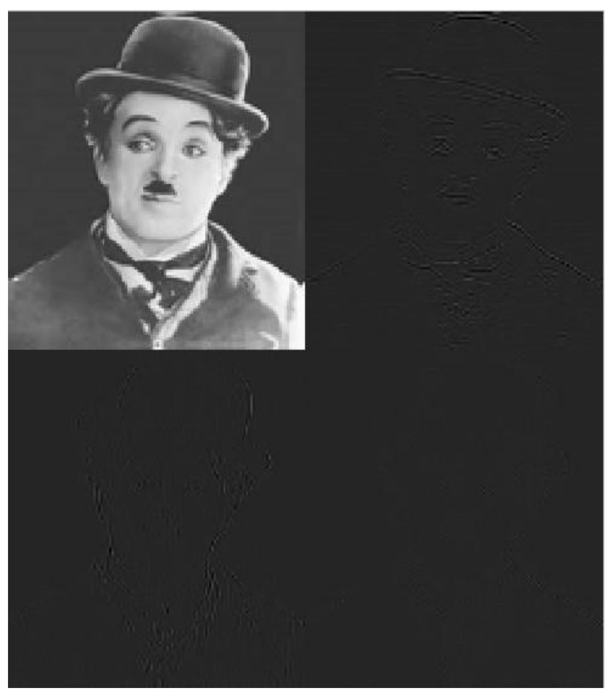

Fig 5.9: After one level 2D-DWT decomposition

Fig 5.10: Reconstructed image after 2D-IDWT

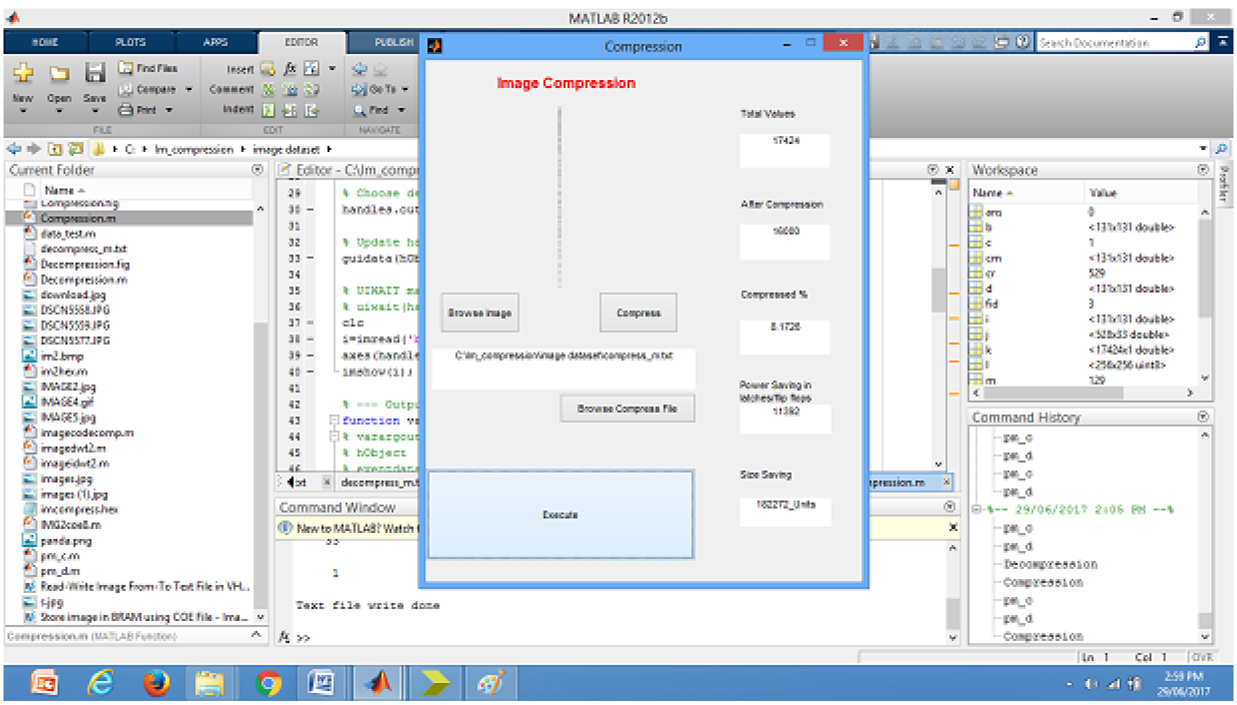

Fig 5.11: Result of compression show in matlab

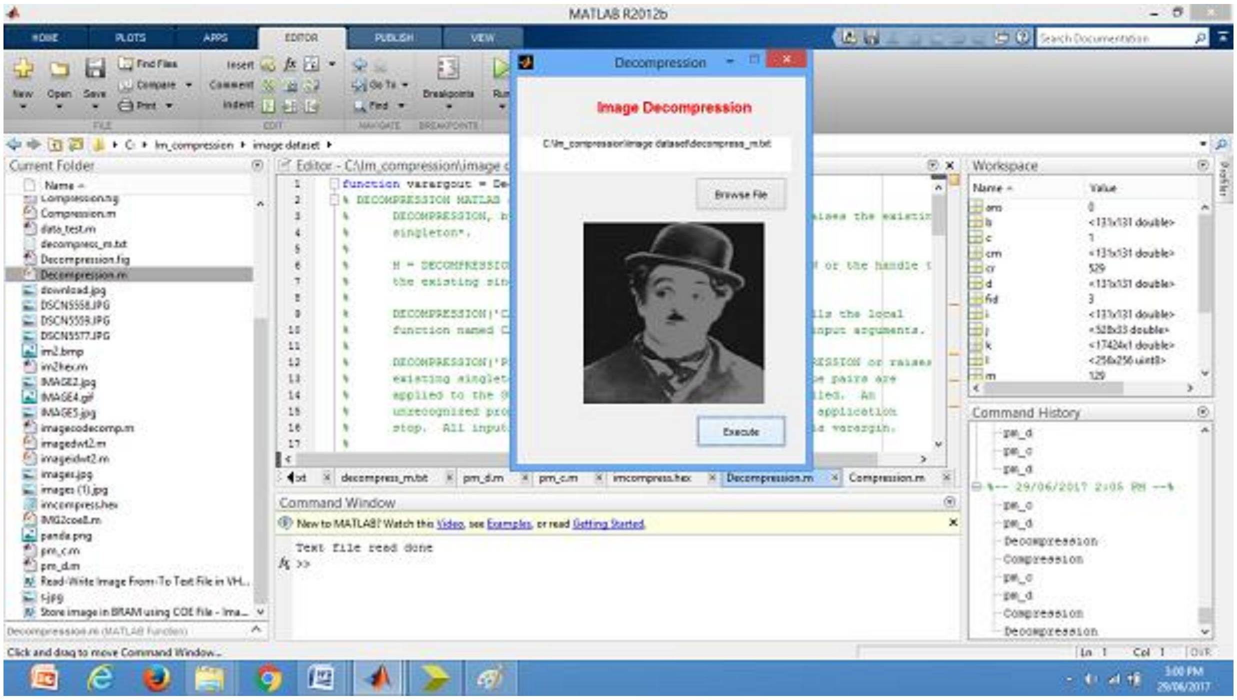

Fig5.12: Result of decompression in Matlab

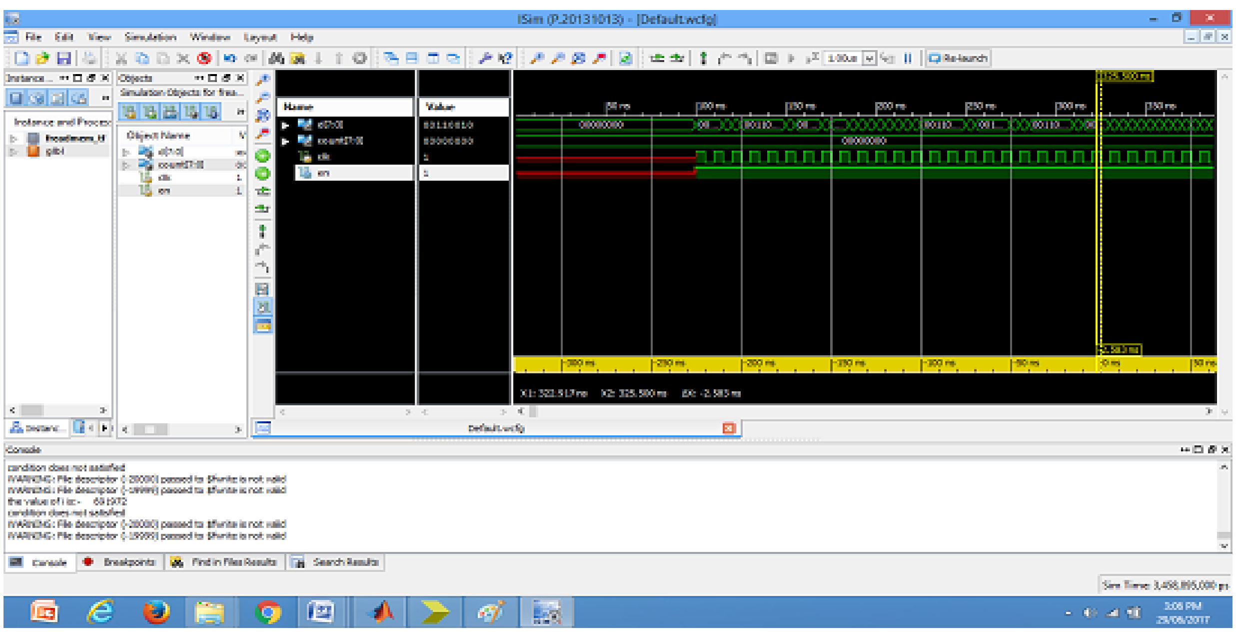

Fig5.13: Output waveform for compression in verilog

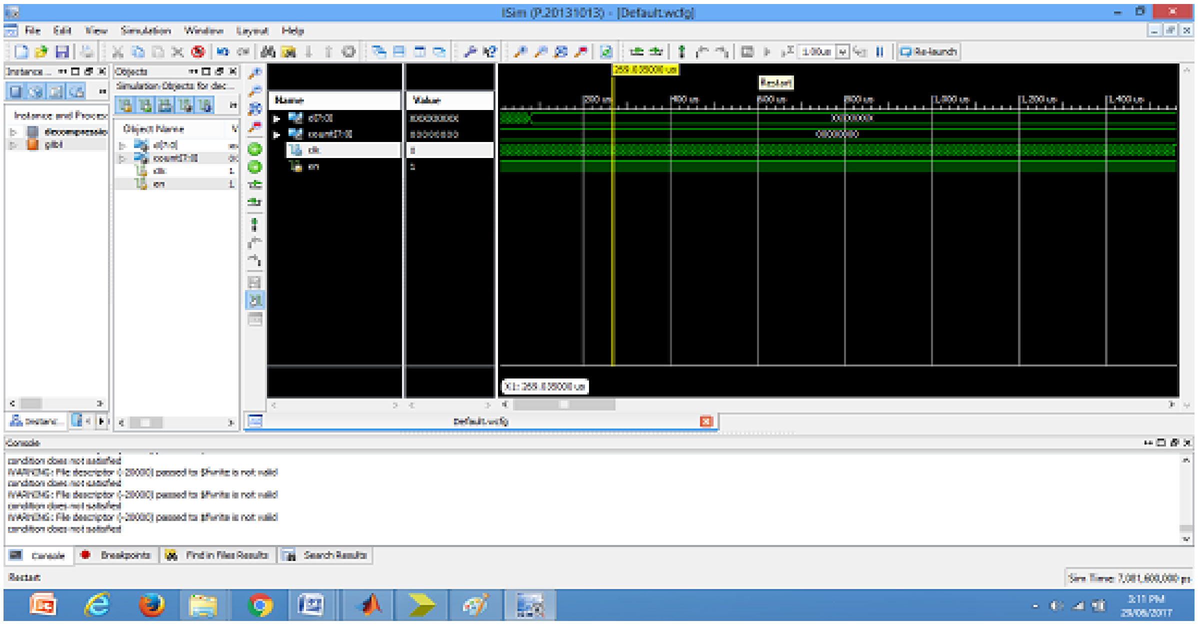

Fig5.14: Output waveform for decompression in verilog

5.1.3 Image 3:

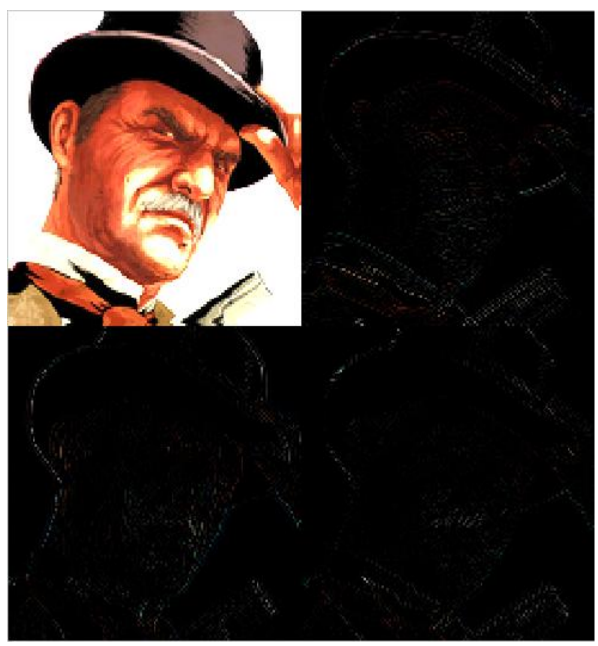

Fig 5.15:Input image **Fig 5.16: After one level 2D-DWT decomposition**

Fig5.17: Reconstructed image after 2D-IDWT

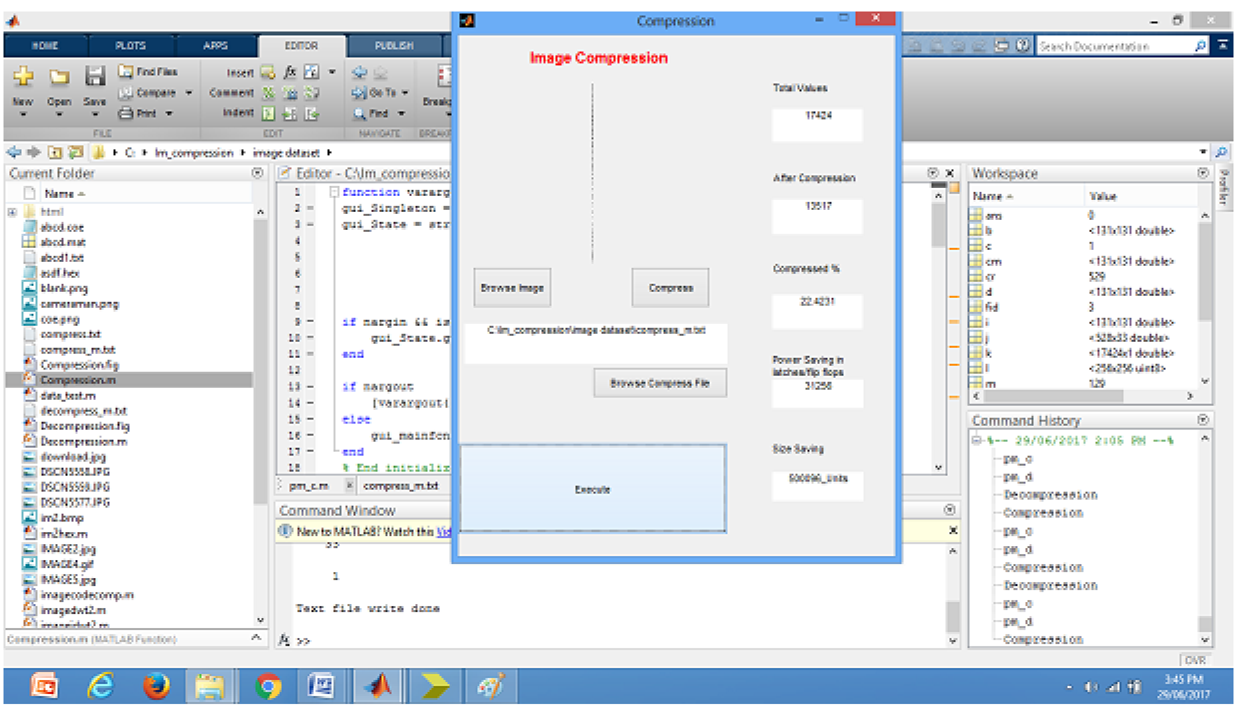

Fig5.18:Result of compression show in Matlab

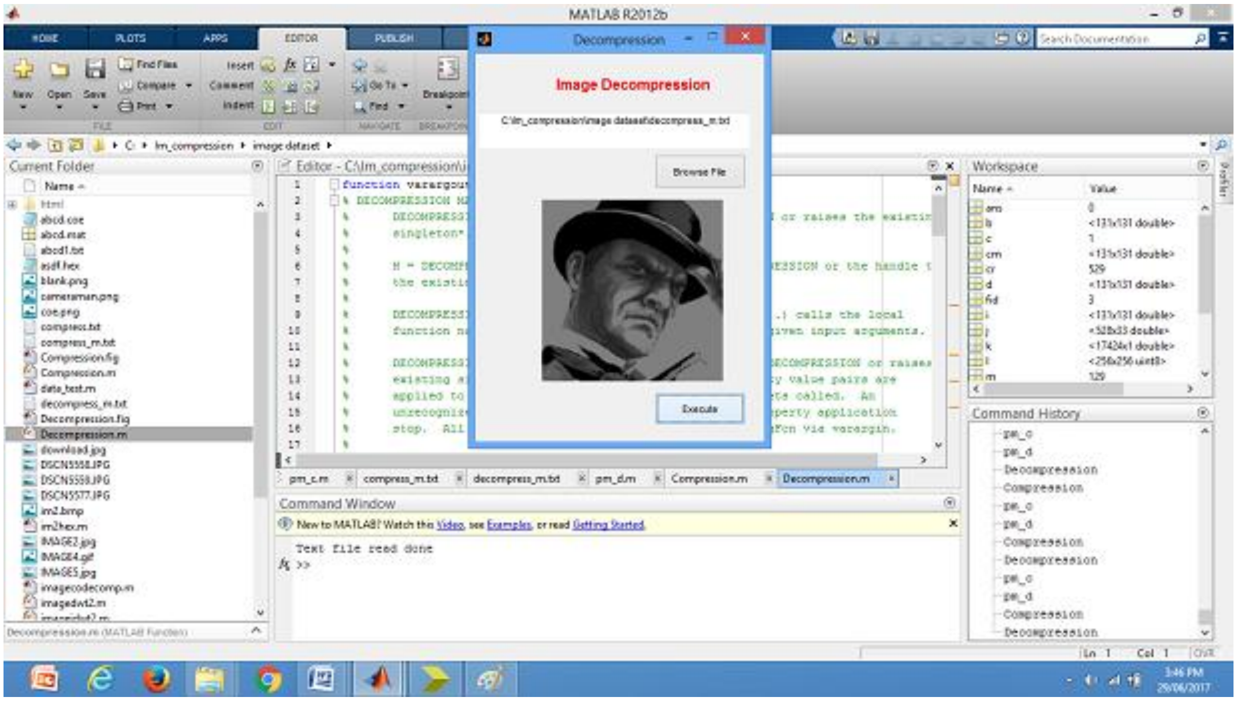

Fig5.19: Result of Decompression show in Matlab

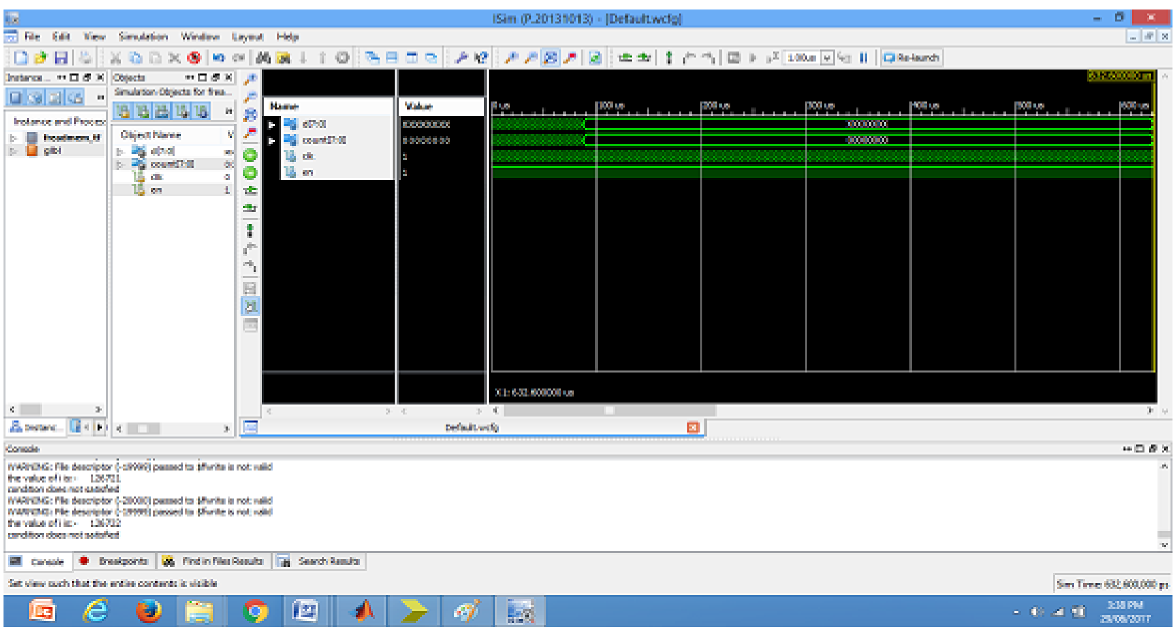

Fig5.20:Output waveform for compression in verilog

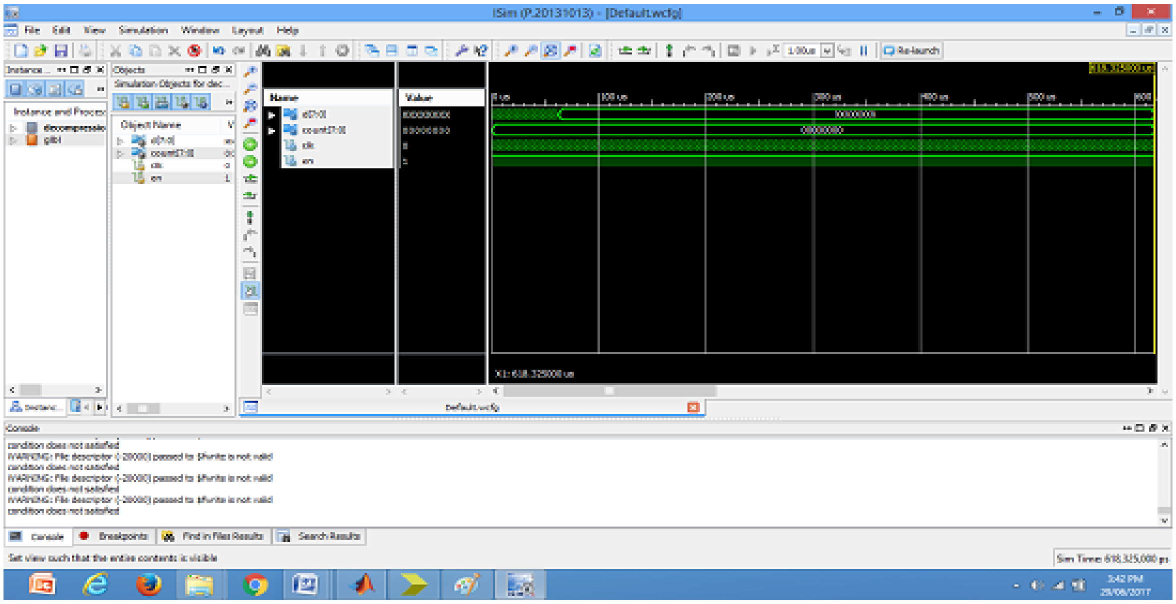

Fig 5.21: Output waveform for decompression in verilog

5.2 Result Analysis:-

From the above discussion, we applied this algorithm on various images in which we have calculated there compression ratio and power save and size saving which we will going to show in the next table:-

S.No.	Test Image	Total Values	Values After Compression	Compression Ratio	Power Saving in latches/ flip flops	Size Saving
1.	Image 1	17424	12975	25.5337%	35592	56947 units
2.	Image 2	17424	16000	8.17265%	11392	182272 units
3.	Image 3	17424	13517	22.4231%	31256	500096 units

Table 5.1:- Table for the compression between compression ratio and Power saving

Chapter 6

Conclusion and Future Work

From the above execution result it is concluded that this algorithm is applicable for every colorful and gray scale image of size 256 x 256 with high intensity. In this compression method we perform compression only those pixel values have 255. By using this algorithm we have achieved image compression ratio and power saving in latches and flip flops , size saving. Result obtain by this algorithm is lossless compression because before compression and after decompression total number of values are equal. As shown in experimental result, Image achieved after compression use less memory space and low transmission bandwidth.

In this algorithm, in future some parameter also adds like as we can calculate correlation coefficient, original image and decompressed image. We can also add compression layer like as perform compression on those pixel which contain zero values, in this thesis we perform compression on 255 pixel values only. If we want to achieve very high compression ratio we also use Neural Network. Which contain three layers for compression.

References

[1] Umbaugh S.E, “Computer Vision and Image Processing: A Practical Approach Using CVIP tools”, Prentice Hall, ISBN: 0-13-264599-8, pp: 504-510, 1998.

[2] M. Antonini, M. Barlaud, P. Mathieu, and I. Daubechies, "Image Coding Using Wavelet Transform," IEEE Trans. on Image Processing, Vol. 1, No.2, pp. 205-220, April 1992.

[3] Olivier Rioul and Martin Vetterli, "Wavelets and Signal Processing”, IEEE Trans. on Signal Processing, Vol. 8, Issue 4, pp. 14 - 38 October 1991.

[4] Evaluation of Design Alternatives for the 2-D-Discrete Wavelet Transform. Nikos D. Zervas, Giorgos P. Anagnostopoulos, Vassilis Spiliotopoulos, Yiannis Andreopoulos, and Costas E. Goutis. DECEMBER 2001, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, Vols. 11, NO. 12, pp. 1246-1262.

[5] https://github.com/alexayin/Noxim.

[6] D. A. Huffman, "A Method for the Construction of Minimum-Redundancy Codes," proceedings of the IRE, Vol. 40, No.9, pp. 1098-1101, 1952.

[7] H. Witten, R. M. Neal, and J. G. Cleary, "Arithmetic Coding for Data Compression," Communications of the ACM, Vol. 30, No.6, June 1987.

[8] D. S. Taubman and M. W. Marcellin. JPEG2000: Image Compression Fundamentals, Standards and Practice. Kluwer Academic Publishers, MA,2002.

[9] R. A. DeVore, B. Jawerth, and B. J. Lucier, "Image Compression Through Wavelet Transform Coding," IEEE Trans. on Information Theory, Vol. 38, No.2, pp. 719-746, March 1992.

[10] A. S. Lewis and G. Knowles, "Image Compression Using the 2-D Wavelet Transform," IEEE. Trans. on Image Processing, Vol. 1, No.2, pp. 244250, April 1992.

[11] https://en.wikipedia.org/wiki/Image_compression .

[12] E. Atsumi and N. Farvardin, " Loss/Lossless Region-of-Interest Image Coding Based on Set Partitioning in Hierarchical Tree," IEEE International Conference Image Processing, pp. 87-91, Chicago, October 1998.

[13] C. Cramer, "Neural Networks for Image and Video Compression: A Review", European Journal of Operational Research, Vol. 108, pp: 147-156, July 1998.