# A NOVEL APPROACH FOR IMAGE COMPRESSION USING PCA AND MULTILEVEL 2D-WAVELET

*Dissertation submitted in fulfilment of the requirements for the Degree of*

**MASTER OF TECHNOLOGY**

**in**

**COMPUTER SCIENCE AND ENGINEERING**


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**May-2017**

**TOPIC APPROVAL PERFORMA**

School of Computer Science and Engineering

**Program :** P172::M.Tech. (Computer Science and Engineering) [Full Time]

**COURSE CODE :** CSE546 **REGULAR/BACKLOG :** Regular **GROUP NUMBER :** CSERGD0238

**Supervisor Name** : Neha Bassan **UID :** 20509 **Designation :** Assistant Professor

**Qualification :** _____ **Research Experience :** _____

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**SPECIALIZATION AREA** : Program Methodology and Design **Supervisor Signature:** _____

**PROPOSED TOPIC** : A novel approach for image compression using PCA and Multi-level 2-D Wavelet

| Qualitative Assessment of Proposed Topic by PAC | | |
|---|---|---|
| **Sr.No.** | **Parameter** | **Rating (out of 10)** |
| 1 | Project Novelty: Potential of the project to create new knowledge | 6.60 |
| 2 | Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students. | 7.00 |
| 3 | Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program. | 7.00 |
| 4 | Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills. | 6.80 |
| 5 | Social Applicability: Project work intends to solve a practical problem. | 7.00 |
| 6 | Future Scope: Project has potential to become basis of future research work, publication or patent. | 7.20 |

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**Final Topic Approved by PAC:** **A novel approach for image compression using PCA and Multi-level 2-D Wavelet**

**Overall Remarks:** Approved

**PAC CHAIRPERSON Name:** 11011::Dr. Rajeev Sobti **Approval Date:** 28 Apr 2017

# ABSTRACT

Multimedia data need efficient storage capacity and transmission rate. The data may be in different forms such as image, audio, video and graphics. These different forms of data are need to be compressed before transmission because they are originally large in size. Because of its large size it cannot be store directly in case low capacity storage device. Compression is all about reducing the image size in pixels without affecting the quality of an image at degradable level. The main part of this report has been devoted to image compression techniques. People want to catch every unforgettable moment of their life. To reduce the size of image redundancy has to remove from images. All the compression techniques are work to reduce redundancy from an image.

The proposed technique is hybridization of PCA and Multilevel 2D-wavelet decomposition. With help of decomposition level it will help in both compression ratio and quality of image. The proposed technique can use for images that from all domain like also work for medical images and social applications. The rapid growth of multimedia applications has increased the demand of image compression. The main objective of image compression is to save bandwidth during the transmission of an image.

# DECLARATION STATEMENT

I hereby declare that the research work reported in the dissertation entitled " A NOVEL APPROACH OF IMAGE COMPRESSION USING PCA AND MULTILEVEL 2D-WAVELET DECOMPOSTION" in partial fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mrs. Neha Bassan. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

*Signature of Candidate*

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# SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation entitled " **A NOVEL APPROACH OF IMAGE COMPRESSION USING PCA AND MULTILEVEL 2D-WAVELET DECOMPOSITION"**, submitted by **Tamanna** at **Lovely Professional University, Phagwara, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

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   Name: _____

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# ACKNOWLEDGEMENT

I would like to present my deep gratitude to concerned people who helped me out to learn this technology.

I take this opportunity to express my profound gratitude and deep regards to my guide **(Ms. Neha Bassan)** for her exemplary guidance, monitoring and constant encouragement throughout the dissertation. The blessing, help and guidance given by her time to time shall carry me a long way in the journey of life on which I am about to embark.

I also take this opportunity to express a deep sense of gratitude to university Lovely professional university for their cordial support, valuable information and guidance, which helped me in completing this work through various stages.

I am obliged to Faculty members of L.P.U, for the valuable information provided by them in their respective fields. I am grateful for their cooperation during the period of my dissertation.

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# CHAPTER 1

# INTRODUCTION

The domain of image processing deal with processing of digital images through mode of digital computers. In context of image processing operations, it includes both the input as well as the output. Its main purpose is to improve photographic image quality for good human perception. Digital image processing is a wide research area and is frequently advancing in technology aspects. In 1972 the digital data began to be widely available in the field of handling remote application. help in handling remote application. This was the time when theory of digital image processing was in its starting phase but the cost of digital computers was very along with having low efficiency. Many new concepts are emerging in image processing which may have certain complexities but have varied applications in different fields.

## 1.1 Introduction

Image is a very important document these days. Everyone is very much fond of images, photos and videos. It becomes a man's wish to capture all his precious moments. This results in huge record of images. Images are of further types medical, graphic and one more category has been added in these days called selfies. Image compression is necessary to save storage space and transmission bandwidth while transmitting images from place to another. Image compression is not only about compressing but after compression its quality should also remain unaffected. The time required to represent image should be less. Image processing can be grouped into four categories:

i. **Image Restoration**: It deals with error and noise while scanning, performing playback and record operations. Basically restoration helps to restore an image that can be recovered using prior phenomenon. Image restoration can recover image using previous knowledge[1]. It is quite similar to image enhancement.

ii. **Image Enhancement**: It compensates for the visualization impact of input image in a way that it provides better information context. Image enhancement helps very to

read document based on history it helps in enhancing the quality of document. Contrast enhancement. Intensity transformations[2].

iii. **Image extraction**: Increases decision making properties of computers which work in making change detections by using principle component images.

iv. **Image compression**: Image compression involves reducing amount of pixels used to represent an image. Reduces the transfer time. It requires less storage space to store. It becomes a time consuming process to transfer image.

## 1.2 Need of Image Compression

Uncompressed image data need significant storage ability and broadcast bandwidth. In spite of rapid progress in storage density, CPU speed & data storage ability data communication bandwidth continues to exceed the capabilities of present technologies. The present growth of digital audio, video and audio based multimedia applications not only continues the compression of such data not only for storage but also for digital message communication technology. Table1 shows the multimedia data and its needed requirements. The information available in table visibly suggests the necessities of image compression[3].

**Table 1**: Multimedia Data Size

| Multimedia data Types | Duration/size | Uncompressed size | Bits/pixel or bits/sample |
|---|---|---|---|
| Color image | 512x512 | 6.29 Mb/image | 24 bpp |
| Medical image | 2048x2048 | 100mb/image | 12 bpp |
| Gray scale image | 512x512 | 2.1 Mb/image | 8bpp |
| Page of text | 11''x8.5'' | 16-32 Kbits | Resolution vary |
| Full motion video | 640x640, 10 sec | 2.2 Gbits | 24 bpp |
| Quality of telephone speech | 1 sec | 64 kb/sec | 8 bps |

## 1.3 Principle behind Image Compression

Image compression is the process of encode an image using a technique that will reduce overall size of an image. Thus if the size of an image will reduce it will also reduce the time needed to transmit an image. Image compression has many applications. But the main aspect of image compression is used to reduce the number of bits required to represent an original image, which can be achieved by removing redundant and visually unimportant information from the image that is not visible to human eyes. Removing these redundancies from the image using compression techniques will reduce size of image. Type of redundancy in image and technique used to reduce these redundancies are interdependent Irrelevant reduction means to remove duplication of original image that is not noticed by receiver. Three types of redundancy are[4]:

a) Psycho-visual redundancy: In this type of redundancy less important information in the image can be eliminated without introducing any significant effect on the human eye. This concept is also known as Human Visual System (HVS).
b) Inter-pixel redundancy: In this technique if the pixel value is reasonably predicted from its neighboring pixel in image that is inter-pixel redundancy.
c) Coding redundancy: Variable length code words are selected from codebook to match the statistics of the original image. There are many techniques which help to remove coding redundancy like Huffman coding, run length coding.

## 1.4 Formats of Images

There are further extensions used with images. Extensions like .bmp, .png, .tiff, .jpeg, jpeg2000 and are used along with image's file name. A pixel value of entered image will be read. Formats of images can easily converted from one format to another according to application requirement. The ones which are in binary format and we work on these pixel values to compress the image[5].

i. BMP (Bitmap): It is commonly used simple uncompressed graphic format by Microsoft windows graphics subsystem (GDI).
ii. PNG (Portable network graphics): PNG supports palette based; gray scale and RGB images.PNG is used for transformation of images on internet rather than for professional uses. For ex: Facebook uses PNG format.

iii. TIFF (Tagged Image file Format): TIFF is more popular and flexible format currently being used rather than other Formats. TIFF supports colored depth image algorithm photographic and art images.

iv. JPEG (Joint Photographic Experts Group): JPEG is designed to compress gray scale images. JPEG is currently working famous format. The extended version of JPEG is explained below.

v. JPEG2000 (Joint Photographic Experts Group): JPEG2000 is wavelet based lossy image compression standard. It is created by JPEG group. JPEG2000 provides higher compression rates but it blurs image more than JPEG.

vi. GIF (Graphic Interchange Format): GIF is very much popular on internet because image size is very much small as compared to above compression types. Table 2 represents Formats of Images.

**Table2:** Format of Images

| FORMAT | NAME | CHARACTERSTICS |
|---|---|---|
| BMP | Bitmap | Uncompressed Format |
| GIF | Graphic interchange format | Lossless : having same pixels like in original one |
| TIFF | Tagged Image File Format | Lossless: Imaging format |
| PNG | Portable Network Graphics | Lossless |
| JPEG | Joint photo experts Group | Lossy and good for photographic images. |
| JPEG2000 | Joint photo experts Group2000 | Lossy and replacement of JPEG |

## 1.5 Types of Images

An image is a visual representation of something. An image is a picture that has been created or copied and stored in electronic form. An image can be described in graphics.

There are mainly 5 types of images that are used by application. Table 3 gives the overviews of images types.

**Table 3:** Types of Images

| **Type** | **Explanation** |
|---|---|
| Binary | Contain only 0s and 1s, introduced as black and white. |
| Black & white | Consists of only black and white images |
| Indexed | Array of class unit8, unit16, single or double whose pixels values are directly related to color map. |
| Gray scale | For single or double logical array value range from (0, 1), for unit8 value ranges from (0,255). For unit16, values range from (0, 65535).for unit16, values from (-32768, 32767). |
| True color | Array of class unit8, unit16, single or double arrays range from (0, 1). |

## 1.6 General Image Compression flowchart

Image compression involves some steps to compress an input image. Generally all techniques follow same compression steps for image compression. Original Image: An input image which we have to compress. Transformer: Transformer helps in transforming the original image into format designed to reduce interpixel redundancies in the original image. Operations are reversible. Quantizer: It reduces the accuracy of the mapper's output in accordance with some predefined criteria.

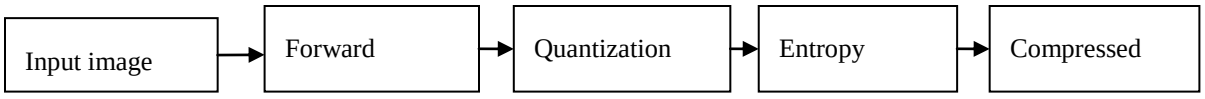



**Figure 1:** General Image compression flowchart

Entropy coding involves creating variable which in reverse can help to convert back to original image during decompression process[6].

## 1.7 Image compression Types

During the past decades, various compression methods have been developed to face major challenges addressed in digital images. These compression methods can be divided into two categories lossy and lossless compression. Lossy compression can achieve a higher compression ratio and it allows little degradation. Examples of lossless compression methods are discrete cosine transformation and wavelet transformation method. Yet it will not recover the original image. There is still a loss of some of information in an image. This compression is applied on images like photographic selfies where small loss of information is tolerable. As in concern of lossless compression it will recover complete original image but compression will be reduced[7].

### 1.7.1 Lossy Image Compression

Most of the lossy compressors are basically three step algorithms, each of which is used for three kinds of redundancy which are explained above It firstly transforms to remove redundancy. Lossy type image compression method is not suitable for images which are having confidential information type of images such as any industrial related technical design. The two main concepts of image compression are redundancy and irrelevant reduction[8].

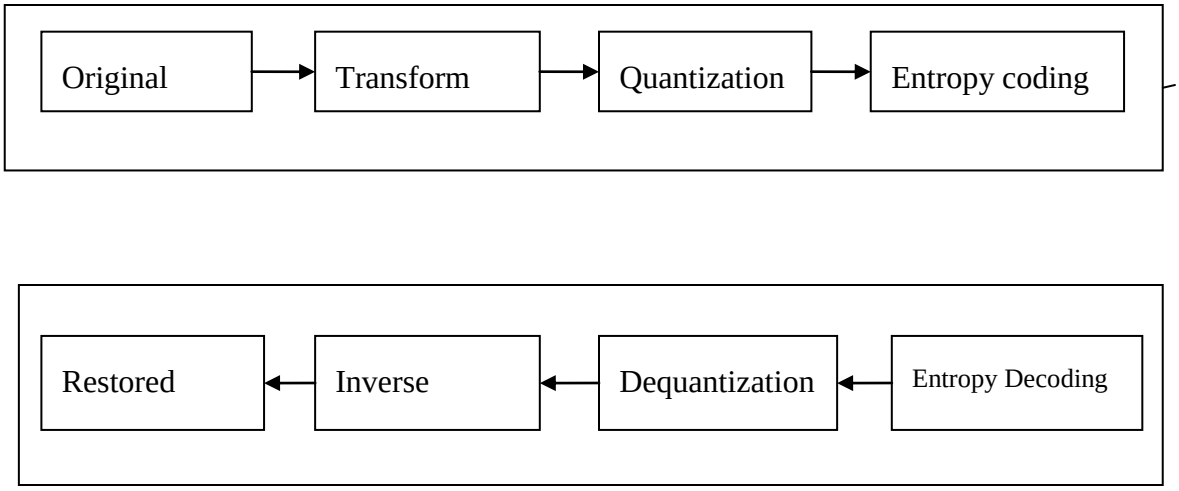



**Figure 2**: Lossy Image compression

**Original Image:** Enter image which we want to transfer it will be first compressed. **Transform:** The first step is transformation to remove interpixel redundancy. **Dequantization:** The Dequantization is simply receiving index and looking for the

corresponding vector code in the codebook. Entropy coding: In entropy encoding the coding method of variable length code is created to represent quantizer output. Transformation: Transform information accurately. Later transformation quantizer is applied to get encoded bits for compression with the coding redundancy.

### 1.7.2 Lossless Image Compression

Lossless compression is a two step process. In the first stage the original image is transformed into some other format so that inert pixel redundancy is reduced. In second stage an entropy coder will remove coding redundancy. The lossless Decompressor is reverse of lossless image compressor. Lossless compression is used in medical images, space images and technical design etc images. In lossless compression quality is not compromised while maintaining its original information. These techniques are widely used since many years and have many applications, were information is more important and we cannot afford to lose it. For entropy encoding three methods are basically used i.e Huffman coding, run length coding and limpel zev coding which are explained below[9]. Lossless compression works well for decorrelated data. Here we categorize lossless compression into two categories:

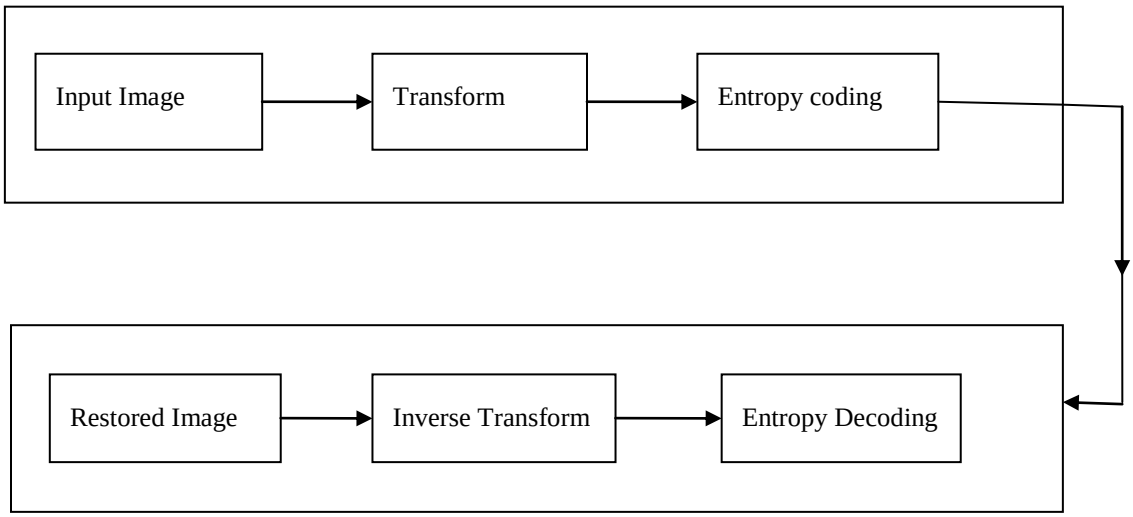



**Figure 3:** Lossless Image Compression

**Entropy decoding:** It involves decoding the compressed image which is encoded above using lossless image compression method such as Huffman coding and arithmetic coding.

After applying such methods we are able to decode the original image after compression and transfer the image from one device to another.

**Multiresolution coding:** Multiresolution coding HINT (hierarchical interpolation) based on sub samplings. It starts working with low resolution version of the input image. Compression is done with both the low- resolution image while error values is in less bits than the original image. Lossless predictive coding: It predicts the value of every pixel by replacing the value of their neighboring pixels. Thus every pixel is encoded with a predictive error which has more value. Entropy coding: entropy coding represents the least size of dataset needed to transfer a particular value of image. Huffman coding, Limpel zev coding and run length coding are best entropy coding schemes which can be used.

## 1.8 Methods of Image compression

Image compression can be done by using three methods coding methods, Transformation Domain and spatial methods[10].

**Coding method:** These methods are directly implemented on raw image and are treated them as a sequence of binary numbers. Coding methods are used to remove coding redundancy from image to reduce size of image. These methods are lossless methods. Coding methods are Arithmetic coding, Huffman coding, run length coding and Lempel ziv coding.

**Spatial Domain:** These methods are combined with coding methods and spatial domain algorithms and it reduces spatial redundancy present in images during compression. Fusion of image has also been done in this type of domain to improve its accuracy. This type of compression is lossless in compressing an image. Vector quantization and spatial quantization are examples of these techniques. Vector quantization method is used to reduce transmission bit rate and require less space to store of an image is required.

**Transformation Domain:** The image is presented during appropriate basis set and the result is obtained as sparse coefficients matrix. Transformation domains are lossy compression methods. The examples of these methods are Discrete cosine transformation, wavelet transformation and Principle component analysis(PCA).Image compression can be done by using three methods coding methods, Transformation Domain and spatial methods. Image compression can be lossy and lossless. For images which are very informational and in which the user cannot afford to lose information. Such types of images are technical drawings, MRI

and all other medical related images. Below Figure 5 shows image compression types and techniques present in those types are presented as follows.

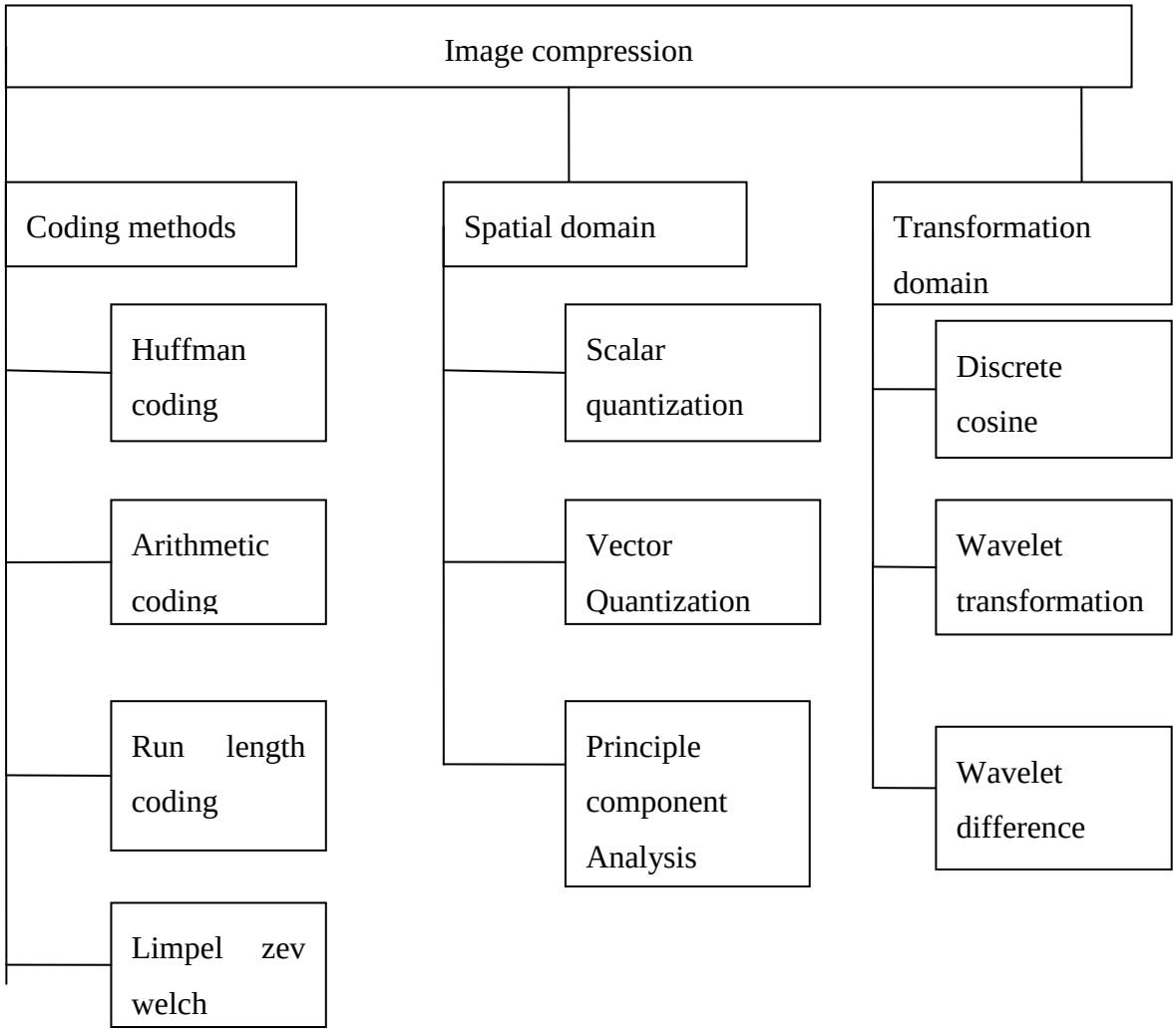



**Figure 4:** Image compression methods

## 1.8.1 Coding Method

**1.8.1.1 Arithmetic coding:** Arithmetic coding assigns a set of bits to a data. It cannot use a discrete sequence of bits for each. The number of bits used to encode each symbol varies the problem assigned to symbol. Low probability symbol uses large bits & high probability symbol use less symbol. The main purpose behind arithmetic coding is to assign symbol an intervals. The starting interval is [0, 1] and each interval categorized in several subintervals in which its various sizes are proportional to the problem related symbols. The final output will be the last interval[11].

**1.8.1.2 Run length coding:** Run length encoding is a lossless image data compression type. It represent image data by a (length, value) pair, where the variable is any repeated value and the variable length is total number of repetitions. For an instance, consider a screen having plain black text on a white background. There can be many long runs of white bits in the black space and many short runs of black bits within the text. Here a single scan line is represented in which X represent a black pixel and Y represented in a white pixel.

XXXXXXXXXXXXYXXXXXXXXX

XXXYYYXXXXXXXXXXXXXXXXX

XXXXXXXYXXXXXXXXXXXXXX

After applying RLE data compression algorithm in above example by using scan line we get 12X1Y12X3Y24X1Y14Y. This can be interpreted as 12 Xs, 1Y, 12 Xs, 3Ys etc. The RLE identifies 67 characters only 18. But actually image data is represent in binary rather than ASCII format but we can apply same process to them also initializing code to string dictionary which contain the single symbol that can be generated[12]. Run length coding is easy to implement and provide better image quality after image compression and image decoding is done. Hybridization of RLE has been done with another lossless methods like Huffman coding, limpel zev coding and many more.

**1.8.1.3 Huffman coding:** Huffman coding can be explained as frequency of occurrence of data item. In this technique they use lower no of bits to encode frequency of data item that occur most frequently. There is also a Huffman coding dictionary that contain each data symbol and associate every data symbol with a code word in the dictionary .This coding is based on the coding tree according to Huffman which gives us small code words to recognize symbol that are frequently used and large code words to recognize symbols that are used rarely used each symbol is encoded with a variable length code. Mostly in cases of images having individual pixels values that are used to represent individual symbol and set of symbol consisting of all gray values of an image[13].

**1.8.1.4 Limpel Zev Welch:** In LZW fixed length codes are generated as concern to Huffman coding which generate variable length coding. In an example we assume that symbols that

present in the source file are a, b, and c and here the string is *ababcabc* which is needed to be compressed. In first step strings are a, b, c. the string can be matched to its position in the dictionary. So the code for a is 0, for b is 1 and for c is 2. The main objective to find the longest prefix of the input image which is in dictionary is a. The longest prefix in *ababcabc* in dictionary is a. Its code 0 is output as part of the compressed file and the prefix and next input symbol can be found in dictionary. This procedure follows again and again until we get code for whole string as output. Thus the coding of string is 01325. Here is encoded string and we can decode it in reverse way[14].

**1.8.1.5 Arithmetic coding:** Arithmetic coding assigns a set of bits to a data item, a string of symbols. Arithmetic coding cannot use a discrete sequence of bits for each. The number of bits used to encode each symbol varies from problem to problem assigned. Low probability symbol use large bits, high probability symbol use low bits. The main purpose behind arithmetic coding is to assign symbol an interval .The starting interval is [0, 1] and each interval is categorized in several subintervals in which its sizes are proportional to the problem related to symbols. The final output will be last interval.

## 1.8.2 Spatial Domain methods

**1.8.2.1 Principal component analysis (PCA):** It is widely used in image processing. It provides us linear subspace. PCA is one of the way to locate matching patterns in group of data it will form pattern in such a way that they will easily identify as their similarity and dissimilarity. Once we are able to find common properties we are able to identify easily. the weakness of PCA which is reduced using linear discriminant analysis (LDA).It is extensively used for dimensional reduction and extracts subspace. PCA works with Euclidean vectors and from several independent vectors recover subspaces. Here is one side of image in which memory is required to store raw data which works in same way as applying PCA for each and every pixel[15].

**1.8.2.2 Vector Quantization:** The most extensively used technique for image compression is vector quantization. The vector quantization methods reduce the transmission bit rate or storage space along image signals. Vector quantization has basically four steps: in the first step vector formation, Quantization, training set values and codebook generation is done. In vector formation the original image is divided into set of vectors. In the final step an input vector, code words are related to this label code word are transmitted. Vector quantization

methods are Luind Buzo Gray (LBG), Fast Back propagation (FBP) and Back proportion neural network(BPNN)[4].

**1.8.2.3 Scalar Quantization:** In many types of lossy compression we have to represent source output using less number of code words. The entire source output that will fall in a particular factor is represented by codeword for that interval. Introduction of related interval will be viewed as design for decoder. Joint photographic experts group (JPEG) is a scalar quantization based technique. Two primary attributes of image compression are redundancy and irrelevant reduction. Reducing irrelevant redundancy aims to removal duplication from the source. Irrelevance reduction permits parts of the signal. JPEG methods are mostly recognized and easy to use image compression standard. Further extended version of JPEG is JPEG 2000 which has more advanced features as compared to previous one[4].

### 1.8.3 Transformation Domain

**1.8.3.1 Discrete cosine transformation (DCT):** This technique involves the transformation of signal into frequency component. It is extensively used in image compression. All standards include Joint photographic experts group (JPEG); Multi photographic experts group (MPEG) and compression of video calling and teleconferencing (CCITT). DCT based technique for image compressions depend on two stages to reduce the representation of input image. First is quantization and then entropy coding[7].

**1.8.3.2 Discrete Wavelet Transformation (DWT):** It is one of the techniques for image compression. Wavelet transformation based technique gives us substantial benefit in quality of image at high compression ratio because of its better energy compaction property of transformation. Wavelet works functions which help in data analysis for image compression. It also represents data with set of high pass and low pass filters. There are also 2D versions of DWT which deals with 2D images output are obtained as LL, LH, HH, HL having vertical elements and diagonal elements[16].

**1.8.3.3 Wavelet Families:** Wavelet families are mainly the group of analogous type of wavelets. Here the main member of family is known as mother wavelet. It can have many members and members have further extensions. Some of them are explained below.[17].

i. **Daubechies wavelets:** This type depends on orthogonal and differentiates by supporting scaling wavelet functions, which identify an orthogonal resolution study. This orthogonal function can be denoted as db1.

ii. **Haar wavelet:** This type is based on orthogonal matrices whose essentials are 1,-1, 0. But the major drawback of this wavelet is it's neither constant and nor differential.

iii. **Coiflets:** This type is same as Daubechies and number of disappearance moments and the scaling function from 2N-1 moment =0 whereas it's main objective is wavelet function have 2N moments=0. These two function maintain length upto 6N-1.

iv. **Symlets:** These are based on asymmetric and greatest number of disappearance moments. They are also known as symmetric wavelets.

v. **Biorthogonal:** These are denoted as bior wavelet, biorthogonal are often used as an alternative of orthogonal i.e. having one scaling and wavelet function , these are two scaling functions that also create dissimilar multi-resolution scrutiny and consequently two different wavelet functions are used in examination and arrangement. Results of analysis chart show that bior1.1 and bior1.3 achieves good compression ratio as well as better PSNR in comparison to other wavelets.

vi. **Reverse Biorthogonal:** This is based on decomposition and reconstruction of dissimilar scaling functions. The above wavelet has removes the moments on decomposition for analysis and also destroys moments on reconstruction or production. It can be denoted by rbio[18].

vii. **Discrete FIR Meyer wavelet:** This is a combination of symmetric, biorthogonal and orthogonal. It is denoted by demay.

viii. **Decomposition Levels:** The number of decomposition level decides the resolution of the lowest level. If we use greater number of decompositions it will be more effective in resolving coefficients from reduce number of components. After compression of image and repeating it with wavelet coefficient high compression can be achieved by wavelet coefficient less thresholding[19].

**1.8.3.4 Wavelet difference reduction:** The WDR is a wavelet based compression follows simple steps of coding. The wavelet transform is implemented on image and WDR encoding algorithm to get wavelet coefficients of images. The main property of wavelet difference reduction is that it gives better compression ratio while maintaining required features. As

hybridization of wavelet with PCA shows that PSNR improve and compression ratio decrease[20].

## 1.9 Performance parameters:

a) **Peak Signal Noise ratio**: PSNR is a parameter used to compare the subjective criteria of original image, basically it a quality measure of an image. Its equation is:

$$\text{PSNR} = 10\log_{10}((m*n)/MSE)$$

Where MSE is mean square error explained below

b) **Compression Ratio:** Compression Ratio is defined as the ratio between original image sizes to the compressed image size.

$$\text{CR} = \frac{\text{Original Image Size } (I_1)}{\text{Compressed Image Size } (I_2)}$$

c) **Mean Square Error (MSE):** MSE is error metrics used to compare in different compression techniques.

$$\text{MSE} = 1/mn \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (X(i,j) - X'(i,j))\text{^}2$$

X (I, j) is the image, X' (I, j) is a compressed image and m*n is a dimension of image.

d) **Bits per Pixel (BPP):** Bits per pixel provide us number that can be able to store in single pixel of the given image.

$$\text{BPP} = \frac{\text{MSE of Compressed Image}}{\text{Total number of pixels in image}}$$

# CHAPTER 2

# REVIEW OF LITERATURE

**Padmavati *et al***. In this paper the author explain most popular techniques such as Discrete wavelet transform, Discrete cosine transformation and fractal method use for image compression. Main applications area of image compression are science imaging, remote sensing and medical images. In proposed technique DCT and fractal quad tree decompressed with Huffman coding. The main aim of this technique is to achieve better compression. In fractal compression the first step is to decompose an image into number of square blocks whereas quad tree is used to reduce search space. In Huffman coding the idea is to assign variable code to input pixels. The result of combining above method using DCT, Fractal quad tree and Huffman coding is reduces the encoding time while maintaining the quality of image. Applications of proposed methodology are medical images and satellite images. For decoding image Huffman decoding is used. The work can be extended for video compression[21].

**R. Praiseline Jasmi *et al*.** In this paper the author discuss comparison of techniques like Huffman coding, fractal algorithm and discrete wavelet transform. The main advantage of these techniques is utilized less memory. Huffman coding helps to reduce redundant data in input images. It is an integer version of transformation methods. Discrete wavelet helps to maintain quality of image after compression. Transformation methods are used for conversion of spatial information to frequency domain for compression color image is used. DWT also helps to reduce noise blurring and unwanted information from image[22].

**Rachit Patel *et al.*** In this paper image compression is done by using Huffman coding technique. The main objective of using Huffman coding is to reduce the redundant bits present in image. Quantization in Huffman coding is to reduce noise present image. Huffman coding is variable length coding and is a step by step process in order to find entropy of the

state of image. Huffman coding is lossless image compression technique which compress image without loss of image quality and less reduction of image information[23].

**Kitty Arora *et al.*** The main aim of compression is to reduce pixels used to represent an image this will also reduce the cost use to store an image. Comparison of above all techniques shows that fractal coding is an effective method for image compression. Fractal method will convert bitmap images to fractal codes. The main advantage of this technique is that it will not look for perfect matches instead it works on 'Perfect fit' matches based on image compression parameters. It provides good compression ratio that will be small in size and need less space to store. In the final stage results are evaluated on the basis of parameters like bits per pixel (BPP), Mean square error (MSE), Compression ratio (CR) and peak signal noise ratio (PSNR). Fractal method gives us better image peak signal noise ratio and compression ratio[24].

**A.Alarabeyyat *et al*.** In this paper author uses CLAHE technique for image enhancement. CLAHE helps to increase contrast of an image whereas using wiener filtering. It is best for image sharpening and by using filtering it reduces the content of noise in equalized image. The proposed technique is implemented using Matlab which is a high level computing language. Main properties of Matlab are uniquely adaptable with vector and array based waveform as core algorithms also suitable for video enhancement[14].

**Saleh Ali Alshehri *et al*.** In this paper neural networks are used to compress an image. In this paper the author discusses how neural networks can be use for image compression. It works on building the training set from different image pixels of original image. It also helps to improve performance of an image. Neural networks also decompress an image but do not provide effective time. In this method the image is decompressed into eight block matrices. In a first step NN can be introduced to compress an image by using less number of hidden neurons. The output of there is hidden neurons along with weight associated with output image. To decompress the image hidden, saved output is multiplied by the weights related to the output nodes. In the final stage of image compression neural networks are constructed to predict the extracted value from matrices to get an image into its original size. By using this

method for image compression 81% was achievable whereas decompression time is negligible. As concern to peak signal noise ratio PSNR is equal to 27.3. After this one more level of neural networks is tried but results are not acceptable[25].

**Ankita Vaish *et al*.** In this paper author the discuss principle component analysis technique used for reducing dimension of an image. It basically extracts dependencies between the variable and introduce high dimensional data in low dimensional form. PCA is also a type of transformation it produces factors equal to number of image pixels. Image compression involves elimination of information which is not visible to human eyes easily. A new technique was introduced using principle component analysis and Huffman coding. Huffman coding is also known as variable length coding. Huffman coding is simple to implement. Huffman coding eliminates coding redundancy. First step is to decompressed image using PCA; most components use construct image and reject the greater components. the decompressed image is further quantized using dithering to eliminate contouring which may had occurred due to less number of principle components are used in image decompression[26].

**C.Saravanan *et al*.** In this paper the author works on image enhancement which is also a keen interest area in the field of image processing. In image processing, an image having low contrast is a challenging problem. Low contrast image involves like noisy, blur image. Image enhancement and extraction of information are two important aspects of image processing. Image enhancement methods helps in improving the visually of any part of image. The main applications of this type of image are medical images, Photographic images, and vision analysis and pattern recognition. One of mostly used method for image recognition is histogram equalization. Histogram equalization can be for color images and for gray images. Histogram is the graphical representation of frequency of gray levels in image equalization in which mean mapping given distribution to flat distribution. Generation of histogram which involves regular AHE, CLAHE can be applied as mapping function[27].

**K. Vidhya *et al*.** In this paper author introduces a simple and effective method for Lossy type image compression. Here transformation (DCT) is applied on Ycbcr image which is obtained

from gray level images. The threshold type and quantized DCT factors are encoded with a proposed technique. The new technique extracts differences in the indexes of the coefficients in coordination with DCT and the transformation is simple consequently it is an efficient compression technique. The direct methods works directly on the images as block transaction and vector quantization methods. The algorithm based on the PSNR criteria will enable the threshold of the DCT coefficients. Further quantization and entropy encoding are performed to finish the algorithm. The efficiency of a method is evaluated on the basis of peak signal noise ratio and bits per pixel to determine quality of the compressed image. In decompression the blocks are decompressed which are obtained by neural networks. After decompression the block has its focus on and size of neural networks. The above purposed methods perform outperforms on all images[10].

**Neha Pandey *et al*.** In this paper a simple lossless compression method is introduced which known as HL and is a combination of both Huffman coding technique and Lempel Zev coding. Huffman coding is simple to implement and yields better results. In first step Huffman coding is used to decompress an image and further results are concatenated with Lempel zev coding. One more algorithm named as swapped Huffman coding is compressed and encrypted analogous to Huffman technique. The introduced method HL enhances effectiveness of the Huffman coding method whereas Limpel Zev coding helps to reduce size. The new presented technique based on Huffman coding and Lempel zev coding known as HL. Compress an image up to an extent. HL effective for images having large size. The work can further be extended to improve compression ratio. This technique is implemented using MATLAB[2].

**Rohit Kumar gangwar *et al*.** In this paper an image is compressed using two techniques Huffman coding and fuzzy logic. After compression, the results shows that compression ratio is low and there is minor difference in original image and the compressed image. Huffman coding is used for image, video and text compression. Huffman coding is a variable code based technique. The second method is fuzzy logic. In fuzzification, a fuzzy set is used to simply increase the fuzziness of fuzzy set. The introduced methodology combining both methods is called Rough fuzzy logic with Huffman coding (RFHA). This new method gives

good results as MSE is low and PSNR values are high. Good compression is adhered a little there is very few loss of information and with high PSNR and low MSE. Thus all three goals are achievable using above new technique. Results show that decompressed and original image is equal in size after decompression. This technique is implemented on a gray type image[28].

**Azadeh safari *et al*.** The author presented the survey paper. In this paper the methods that are discussed are DCT, DWT and the recent method which is the combination of both named as hybrid. Images are compressed to get high value of PSNR and CR. Image is mainly compressed by removing the visible elements. Benefits of image reduction is the reduction of transmission rates. DCT partitioned an input image into parts of dynamic frequency and less necessary frequency is discarded and the needed frequency is used to compress an image. Wavelet transformation of an original image as a sum of factors that we get from wavelet transformation. Here we implement multi resolution using wavelet factors and scaling factors. The results that are provided by wavelet transformation is better thus wavelet transformation is better method. In the new technique properties of both DCT and DWT are combined in the hybrid technique. In proposed methodology author wants to do further work on hybrid methodology. By using fuzzy logic in it. Fuzzy logic applied in three parts: Image fuzzification, modify membership value, the final stage is image deffuzification[29].

**Ran Hu *et al*.** In this paper author discussed JPEG standard works in three stages: Mapping reduction, interpixel redundancy and final is quantization. JPEG standard is lossy image compression technology. Here combination of both technology JPEG and Huffman coding is discussed. Huffman works as reducing number of symbols by joining all of them and make a new one. Performance of standard JPEG is improved in the new methodology. An entropy coder is an mapping from an event to a bits in sequence. The ways in which events are defined are known as entropy coder. Huffman coding works better in text images. In forward discrete cosine transformation images are firstly divide in blocks of size 8X8 and images are shifted to integer with range limited integers. After quantization of the related coefficients is order into sequence. JPEG standard are ordered into a zigzag sequence. JPEG standard works with two entropy coding known as Huffman coding and arithmetic coding. Degradation may

occur due to reason of blocking effect. The introduction enhances the performance of JPEG technology. This method is best suited for all types of images[8].

**Jihaas Khan *et al*.** In this paper author discussed new technique known as code book design. The advantage of this technique is its innovative way which helps to minimize the compression ratio of an original image in multiple iterations. Two levels of book code design are explained in his paper. Compression of book and identification of code book number. This method works better if the image is of exact types such as passport images. Number of columns and rows are designed into image pixel values of original image. The decompression is performed using basic book code design. The author also discuss drawback of this technique such that its format has higher value of binary bits used to represent the image compression pixel values. Here compressed information for original image having unique identity value of the code book design will send to decompression stage[5].

**S.P.Raja *et al*.** In this paper author hybridized two techniques namely EZW and WDR and then comparison of results has been done. The EZW stands for Embedded Zerotree Wavelet and WDR is for wavelet difference Reduction. WDR having all the features like less complexity, ROI and better PSNR. The main objective of paper works in two ways in first step image is compressed by using WDR and EZW and the results are compared with parameters PSNR and CR. The basic of EZW identify self similarity across distinct parts of a wavelet image transform. Discarding coefficients of high frequency results to some degradation at a particular location of an image rather than effecting whole image. Both techniques help in picture quality. The EZW has been attached with Multiresolution analysis provide significant compression with little loss of information. As compare to EZW technique WDR helps in high PSNR. In future author combine WDR with arithmetic coding[3].

**Bindulal T.S *et al.*** In this paper author use medical image transmission depends on the wavelet based coding method. Author purpose scalable wavelet difference reduction (SWDR) based on wavelet difference reduction technique. The proposed method will work

for limited network bandwidth where image transmission and image quality is main concern. The run time is also reduced for because the scheme use run length coding instead of zero tree coding.WDR is work as one of the alternative for SPIHT technique which helps in reconstruction and use for run length coding scheme for coding images. Scalable WDR supports spatial and SNR scalability[30].

**F.Jin *et al.*** PCA is a method in multivariate stastical analysis and its main idea is to reduce dimensionality having variables and samples. Author works on Shannon information theory and works on two important concepts namely possibility information entropy (PI) and possibility information entropy (PIE) and purpose improve principle component analysis namely (IPCA) .The newer method IPCA when compared with PCA results shows that IPCA method is more efficient than and principle component of IPCA have more information as compare to simple PCA. We use two new concepts information rate (IR) and accumulated information rate (AIR). The two concepts PIE and PIF depend on eigenvalues and eigenvectors from their principle components. The proposed method IPCA works as further extension and perfection of PCA[31].

**Ko Nishino *et al.*** In this paper author worked on limited scalability of technique PCA and propose a new algorithm named clustered PCA. Due to inherent computationally complexity a new method is introduced for applying PCA method to visual data which takes benefits of spatio-temporal correlation and frequency variations that are typically found in visual data. In this method instead of working on whole method and apply PCA to whole data firstly partition the data into blocks and then apply PCA to each and every block and then combine into a set of blocks and group them together. As a result we can use PCA to handle large data sets. The introduced method is applied on videos. As future work author examine methods for estimating optimal and temporal block size allows varying diagonally through the data volume. This problem remains there which reduce the availability of practical algorithms[15].

**Rafael do Esprito Santo *et al.*** In this paper author applied the concept of principle component analysis in digital images like medicine. The concept has been implemented on

digital image which is collected on daily routine basis. The compressed image retains the principle characteristics of original size. Author also explains importance of PCA in area of image compression.PCA works with classification of standards in available data according to the way that their similarities and differences can be identified. The best possible axes may be found using Singular value decomposition (SVD) method. The extent of principle component used for compression effect reloading of original image. This also helps in storage space which is necessary for clinical based applications and deal with large volume of data.

**Kamrul Hasan Talukder *et al.*** In this paper author proposed that low complex 2D compression using wavelet as a basic method and various approaches are used to measure quality of images. The particular method here used for wavelet is Haar wavelet. The 2D-DWT method has been applied to guesstimate matrices. Many web applications like teleconferencing, high definition television (HDTV) are not possible without compression. wavelets are also good property for computer graphics. Wavelet based compression provide improvements in picture quality and higher compression ratio. Quantizer is also used to decrease number of bits needed to store transformed factors. The quality of compressed images are evaluated using parameters PSNR, Mean opinion score(MOS), Picture Quality score(PQS).As a future work the tradeoff in the value of threshold E and image quality has been identified. More thorough study of still image compression may be calculated[32].

**Sandeep kaur *et al.*** In this paper a detailed study of various wavelet based image compression has been done. Wavelet is finite energy signal that can be explain over specific interval of time. Wavelet can be joined using reverse, shift, multiply and sum technique known as convolution. Various wavelet based methods are continuous wavelet transform (CWT), Discrete Wavelet transform (DWT), wavelet packets and Fast wavelet transform. Image quality parameters such as PSNR value and compression ratio. Wavelet types Haar, symlets and biorthogonal have been applied to image and performance can be evaluated based on qualitative and quantitative methods. Wavelets packets are like waveforms indexed by three interpreted parameters such as position, scale, and frequency. DWT reduce the problem of artifacts and it has many advantages over DCT[12].

**Tripatjot Singh *et al.*** This paper introduces two techniques based on wavelets named as wavelet transforms and wavelet packets popular for transformation based image compression techniques. Compression ratio and energy ratio are two quality measures use for distinct wavelet at different threshold values vary from 5 to 100 for decomposition value. Discrete wavelet packet transforms (DWPT) works as cutting edge technique in image compression. In first step image is quantized and finally thresholding is performed which makes coefficient value less as obtained from quantizer. Here wavelet based wavelet Haar and wavelet Dmey are compared and results shows that Wavelet Demy gives better results as compared to wavelet packet. As well as wavelet packet also helps in Compression ratio[33].

**Rusem Oktem *et al.*** this paper introduces a technique for efficient coding of dyadic wavelet transform coefficients. This method works according to identify interband and interaband dependencies. Results clearly shows that wavelet packet works better and provide better results over dyadic wavelet transform. Another algorithm which works with rate distortion WPT. Dyadic wavelet decomposition can be achieved by perfect filterbank operations for low frequency bands. Wavelet packet decomposition can be achieved by filterbank that can be repeated for all frequency bands for each level. A new criteria of calculating a parent-children connection with wavelet decomposition bands has been introduced[34].

**Michael B. Martin et al.** This paper illustrates that wavelet based methods are best for JPEG based photographs. For better results in image compression wavelet transformations require filters that use to combine number of required properties. Multiwavelet having more properties and can be combined with multiple required properties. The author also introduced multiwavelet packets. Results show that these techniques performed better than previous one. Besides its general accuracy the wavelet transform often does not work for high frequency. A single level of decomposition partition the input signal into low pass and high pass factors as compare to iterating. Wavelets packets also works with increased complexity for basic selection process[7] .

**Vikas Pandey et al**. In this paper author examined a basic concepts about wavelet wavelets including wavelet transform, discrete wavelet transformation and principles of image

compression and image methodology. The main objective of doing this analysis is to select suitable method transformation for compression the gray scale image and maintain the quality of original image. Wavelet families include DWT, haar, Daubechies, Biorthogonal, symlets and coiflet name also been applied to image and their qualitative and quantitative results are also presented in terms of quality measures PSNR and CR and MSE values. In wavelet its wavelet transform and its inverse can be used for transform and its inverse transform. The main advantage of wavelet is that it can be adaptable and thud can be intended for individual applications. Results shows that large amount of data has been lost in original image but it can be recovered with using wavelet families and get good PSNR and CR values. Wavedec2 performs the decomposition of original image for desired level with great level desired wavelet having N levels with function(wname)[35].

**Ramandeep Kaur *et al.*** In this paper author compare works of symlets and Biorthogonal wavelet algorithm. Quality metrics are used for evaluation are PSNR, MSE, Root Mean Square Error(RMSE) and two added quality metrics are Universal Image Quality(UIQI) and Mean structural similarity image(MSSIM). The compression has been performed on JPEG 2000 format. The main aim of wavelet transform is to convert data from time space to frequency domain in order to achieve better compression. These calculated signal are decomposed into high frequency, low frequency and approximation frequency. The image data is filtered out at each level and then required HL, LF is filtered out from required columns. At each level of decomposition four sub images are calculated namely horizontal detail, vertical detail, approximation detail and diagonal detail. The algorithm has been implemented in MATLAB 2010b[36].

**G. Sadashivappa *et al.*** In this paper author discusses necessary features of wavelet functions and filters used for sub band coding to covert original image into wavelet coefficients. The quality can be measured using parameters namely PSNR and bit variation (bpp). Wavelet coder has available three components a transformation, quantizer and an encoder. Here zero trees can be used for efficient and embedded presentation of quantized wavelet coefficients. Refinement pass allows for approximation needed quantization of significant coefficients. The synchronized information of list of information helps in

compression of image whereas SPIHT is susceptible to data loss. SPIHT use EZW for encoder purpose but most of times it performs better without any loss of arithmetic encoder. SPIHT perform in two stages sorting and refinement. In sorting the threshold level is 2n where n denote bit level following its initial value[3].

**C. Lv *et al.*** A new hybrid method K-PCA was introduced in this paper. In this method first of all here obtain K number of sets of eigenvectors for distinct image blocks with different properties using some type of training data. Here only K-type set used for compressing the image. However vector quantization is also used to divide the training data set. The basic idea of this paper is to increase overall performance of PCA. A general PCA is also adopted to decrease time for creating VQ10[37].

**C. Kamargaonkar *et al.*** In this paper two extended PCA has been discussed for medical images. PCA is a stastical method that transfer, a variable of original image into less number of unrelated variable. In medical images it is required to keep safe details needed for diagnosis PCA is used for image data dimensionality reduction can be justified for multidimensional data. General Next block by block PCA is introduced in which an image is divided into blocks and then PCA is applied to each and every block. A new AI based segmentation in which partitioning an image into different regions based on their properties like gray level, contrast, color and effulgence. In proposed work non-ROI region is compressed by general PCA and ROI region with block-based PCA. Using this segmentation method we can achieve CR upto 98% and there is no loss of information on ROI region[38].

**Mohammad Mofarreh-Bonab *et al.*** In this paper while working with general PCA an improved version of PCA known as kernel –PCA and 2D-PCA is introduced. A new method is described to compress an original image using 2D-PCA technique. The speed of method can grow with the help of parallel programming. One of the important advantage of this method is that it requires less time to reconstruct compressed image as compare with other latest JPEG formats[39].

# CHAPTER 3

# PRESENT WORK

## 3.1 Problem formulation

In image compression the main concern is always quality of compressed image and time taken to compress an image. In this paper with the help of proposed methodology improvements in PSNR has been done. In existing technique Principal component analysis (PCA) and wavelet difference reduction has been implemented. In existing method large number of PC's has to use which reduces CR value. In proposed technique less number of principal components have to use. The drawback of existing method is that it works only for multimedia images.

- In proposed methodology image hybridization of PCA with multilevel 2D-wavelet decomposition is done. In multilevel 2D-wavelet the concept decomposition level is used.
- The proposed methodology will help to identify value of three more parameters which are MSE (Mean Square Error), CR (Compression Ratio) and ET (Execution Time).

## 3.2 Objective of study

Image compression is all about compress an image with less affect on the quality of image. Our main objective is to improve quality (PSNR) of an image. For compression we have to do dimension reduction in an image. It can be done by using principle component analysis technique. Only PSNR parameter is not enough for deciding performance of hybridized technique so that more parameters have to introduce.

- To improve PSNR (quality parameter) value.
- To get better compression ratio.
- To save bandwidth while transmission.
- To introduce more parameters for example encoded time and mean square error.

## 3.3 Research methodology

In this paper hybridization of two image compression techniques has been done. Principal component analysis (PCA) is a technique which helps in quality of image but compression ratio is less. This can a restriction for image compression applications. In order to resolve this hybridization of PCA with multilevel 2D-wavelet has been done. Multilevel 2D-wavelet helps in quality also in compression ratio. Advantages of Wavelet transform are that it gives good compression ratio and better quality. Wavelet family involves members Haar, orthogonal, biorthogonal etc. In this paper biorthogonal has been used over orthogonal.

**3.3.1 Principal component analysis (PCA):** PCA is a non parametric technique of extracting useful information from large data sets. Principal component analysis (PCA) has been widely used in image processing like image compression and image classification techniques. PCA is stastical technique also work for application such as face recognition. Principal component analysis work as a vector space transform which is often used to reduce multidimensional image data set to less dimensions for examination. PCA transform the number of interrelated variables into discrete variables known as principle components[40]. The advantage of PCA is that when image data size is compressed also dimensions are changed but there is no loss of necessary information at reconstructed image.

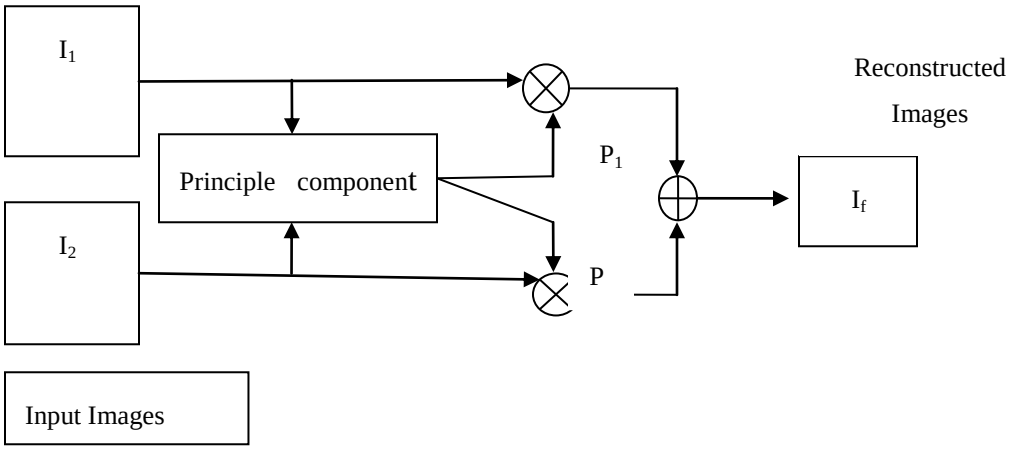



**Figure 5:** Flow chart of PCA

SVD is used to perform PCA. SVD is used to decompose an image into three matrices U, ∑ and V.∑ is a diagonal matrix having singular values in descending order. U, V are orthogonal matrices. The steps to achieve PCA using method of SVD are given below.

i. Take an original image I of size *pxq*.
ii. Subtract mean as from each columns of I, which will make a mean centered matrix A.
iii. Generate matrix X using step 2 on A, and then determine covariance matrix $XX^T$ and execute SVD on it.
*iv.* For an original image of size *pxq*, having orthogonal matrices U and V are of size *pxp*, *nxn* and diagonal matrix ∑ size is *pxq*
v. Opt for few dominant PCs.
vi. Project data to original basis.
vii. Display reconstructed image.

PCA helps to determine eigen values and eigen vectors using. Less number of principle components means better image quality.

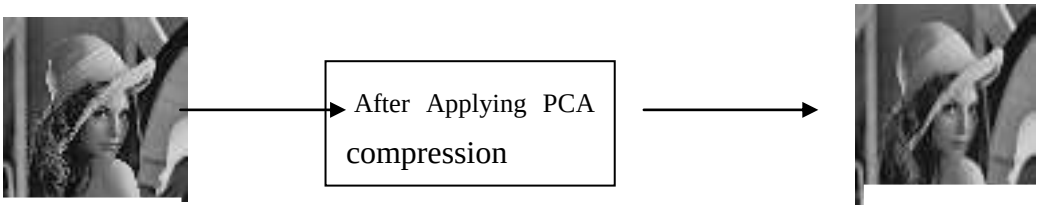



**Figure 6:** Image is compressed using PCA compression

**3.3.2 Multilevel 2D-Wavelet Decomposition:** Wavelet transform is use to evaluate mathematical methodologies. Wavelet transforms are sampled by additional wavelet transforms in DWT. The main application of wavelet transform is temporal resolution. 2D wavelet are used for image of any image processing applications. Wavelet decomposition level is based on two concept of filters a) Low pass filters b) High pass filters. This decomposed into four distinct frequency bands low pass band (LL), diagonal (HH) high pass bands, horizontal (HL), vertical (LH). In multi wavelet transform, the transform will be implemented by using multi wavelet functions and scaling functions[41]. These multilevel wavelet have advantages such as orthogonal, symmetry and approximation in contrast with other multi wavelets. The algorithm steps for wavelet decomposition.

i. Take an input Image I.

ii. Wavelet individually filters I(x, y) and down the 2D image in vertical and horizontals directions.

iii. Coefficients matrices $I_l(x, y)$ and $I_{H(x, y).}$ Both matrices are filtered down and two sub images are created namely $I_{ll}(x, y)$, $I_{LH}(x, y)$, $I_{HL}(x, y)$, $I_{HH}(x, y)$.

iv. Sub images contain horizontal, vertical and diagonal information of the input image I(x, y). More resolution can be achieved by applying same method to low pass coefficients.

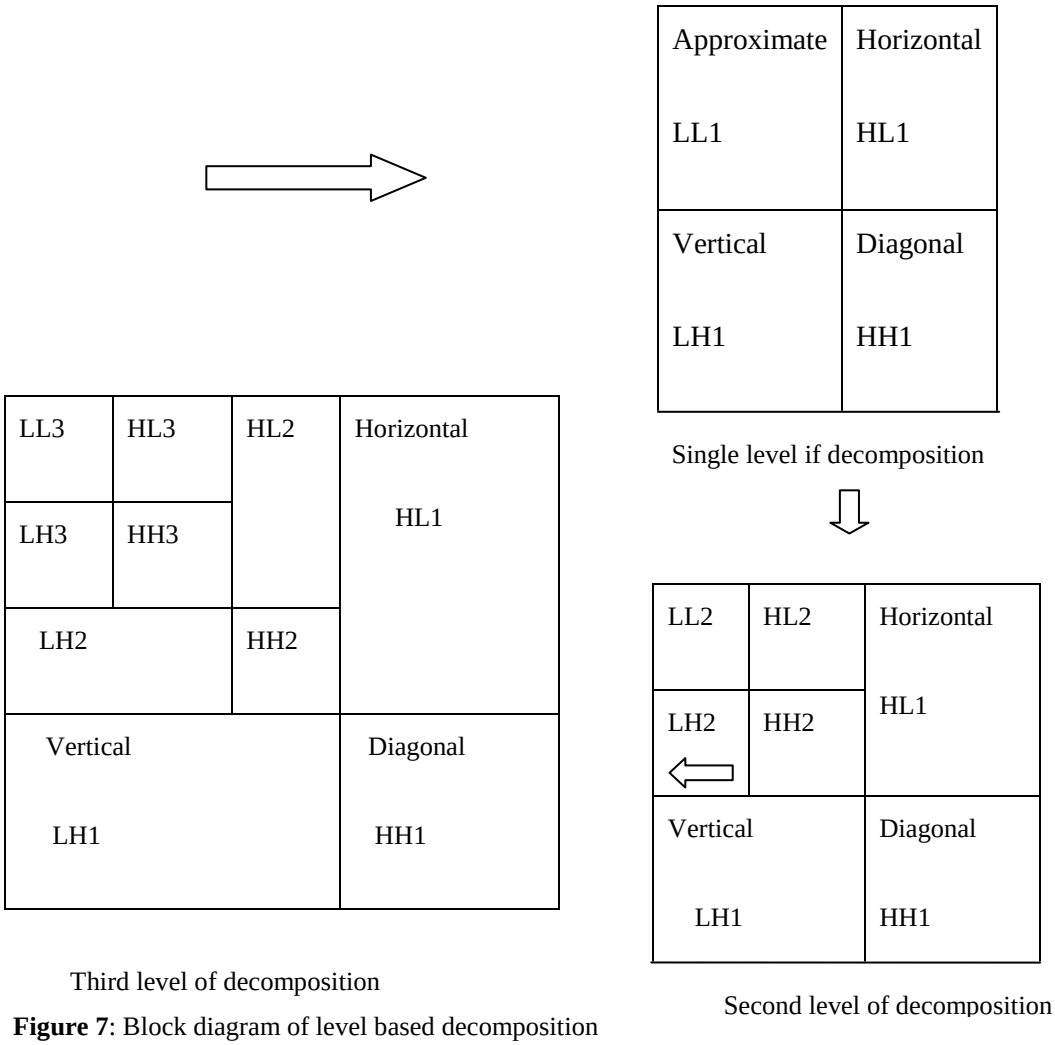



**Figure 7**: Block diagram of level based decomposition

**3.3.3 Tool: MATLAB** abbreviated as Matrix laboratory. MATLAB is mathematical computing enviournment and fourth- generation programming language. It is introduced by

Math Works; MATLAB allows matrix manipulation, implementation of algorithms, plotting of functions and data, creation of user interfaces, and interfacing with applications programs written in other language, C, C++, Fortran, and Java. MATLAB is primarily works for numerical computing, toolbox works with MuPAD engine, allowing access to another computing activities. An added package simulink, multidomain simulation, simulink, adds graphical multi-domain simulation and also design for embedded and dynamic systems. In this paper one of the important applications of MATLAB image compression has been used.

**3.3.4 Performance Parameters:**

The image quality can be identifying objectively and standards methods are there. Those parameters are peak signal noise ratio (PSNR), Compression ratio (CR), Mean square Error(MSE) and Execution time(ET) are there[11].

a) **Peak Signal Noise ratio:** PSNR is a parameter used to compare the subjective criteria of original image, basically it a quality measure of an image. Its equation is:

$$\text{PSNR} = 10\log_{10}((m*n)/MSE)$$

Where MSE is mean square error explained below

b) **Compression Ratio**: Compression Ratio is defined as the ratio between original image sizes to the compressed image size.

$$\text{CR} = \frac{\text{Original Image Size } (I_1)}{\text{Compressed Image Size } (I_2)}$$

c) **Mean Square Error (MSE):** MSE is error metrics used to compare in different compression techniques.

$$\text{MSE} = 1/mn \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (X(i,j) - X'(i,j))\text{^}2$$

X (I, j) is a image, X' (I, j) is a compressed image and m*n is the dimension of image.

d) **Execution Time (ET):** The distinct algorithm of image compression follows the different steps. Because of this there is a measureable difference in execution time. The technique to be suitable for the processing time its execution time should be small. The execution time can be calculated in seconds.

**3.3.5 Proposed Methodology:** Steps for proposed algorithm are described below. In this paper hybridization of two techniques Principal Component analysis (PCA) and multilevel

2D-wavelet are combined. The main objective behind this hybridization is to use advantages of both methods. PCA helps in image quality and multilevel 2D-wavlet helps in quality as well as compression ratio. Thus by applying both methods there is very low effect in quality. Even the loss is not identifying by human eye. Hybridization has been implemented on 8 bit gray images. The techniques are implemented in MATLAB are as follows:

i. Read the grayscale input image from computer(image dimension 512x512)
   a) Start of PCA algorithm
   b) PCA has been implement using SVD
   c) Calculate mean from every column until zero value
   d) Find covariance of matrix
   e) Compute eigenvalues and eigenvectors.
   f) Only few dominant Principal components are selected. These components are used by multilevel 2D-wavelet to reconstruct image.

ii. Set level of decomposition (require in 2D-wavelet).

iii. Apply 2D-WT using various wavelet and decompose an image from level 1 to n-level

iv. Extract the level 1 coefficient which is LL1, LH1, HL1, and HH1.

v. Level n coefficients are LLn, LHn, HHn, and HLn. where LLn is for approximation at nth level. LHn horizontal at nth level. HLn vertical at nth level. LLn diagonal at nth level.

vi. Set the threshold value. This is needed because many of wavelet coefficients are equal to zero or near. With threshold coefficients can be change.
   a. Multilevel reconstructed image is there.

vii. Calculate Peak signal noise ratio (PSNR), Mean square error (MSE), Execution time (ET) and compression ratio (CR).

viii. Evaluate the results you have calculated to analyze performance of hybridization techniques.

ix. Repeat steps from step 2 to step 6 over again for different results.

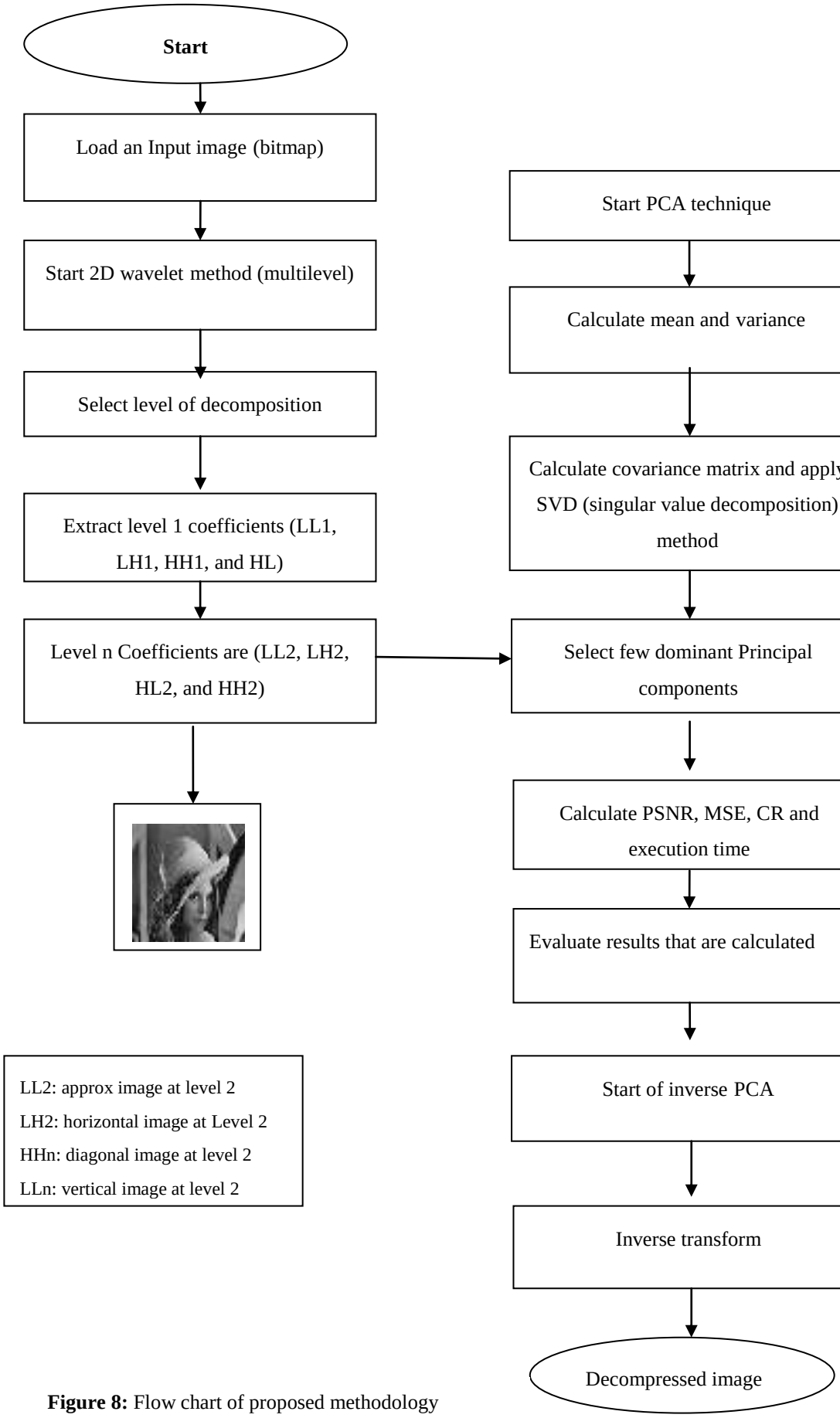



**Figure 8:** Flow chart of proposed methodology

# CHAPTER 4

# RESULTS AND DISCUSSIONS

## 4.1 Experimental Results

In this chapter results of hybridization of results are illustrated. The proposed methodology is practical on several images and equivalent to PSNR, CR, MSE and ET are calculated for all images. Images that are having same PSNR value but there is difference in visible quality. The quality of reconstructed image can be identifying in two ways subjective and objective ways are there. In subjective only eyes determine image quality whereas in objective stastical methods are there. The quality of image can directly identify if there is high PSNR and low MSE. All the experimental steps are performed on the several test images like pepper, Lenna Barbara, baboon, boat and Baby.

**Peak Signal Noise Ratio (PSNR):** PSNR parameter is measure of peak error. PSNR is used to express in decibel scale (db). A high PSNR is very good with PSNR means ratio of signal to noise will be higher. Signal will represent input original image and noise will represent error in reconstructed image[11]. It is the proportion between the highest feasible power of a signal and the rule of the corrupting noise. PSNR reduces as the compression ratio increases for an image. The PSNR is defined as: PSNR= $10\log_{10}((m*n)/MSE)$

a) Original image b) PSNR=40.67 d) PSNR=71.1002

**Figure 9:** a) Original image reconstructed image b) PCA c) Existing technique d) Proposed technique

Above Figure 11 shows the a) original input image b) PSNR value of image compressed by existing technique d) PSNR value of image compressed by proposed technique. Values shows that alone PCA is not helping in quality much as compare to proposed methodology.

Figure 10 shows the overall performance of PSNR of different images (Lenna, Barbara, Boat, camera) images are of size 512x512 of 8 bit gray level images. A the value of principal component increases PSNR value increase but compression ratio reduces.

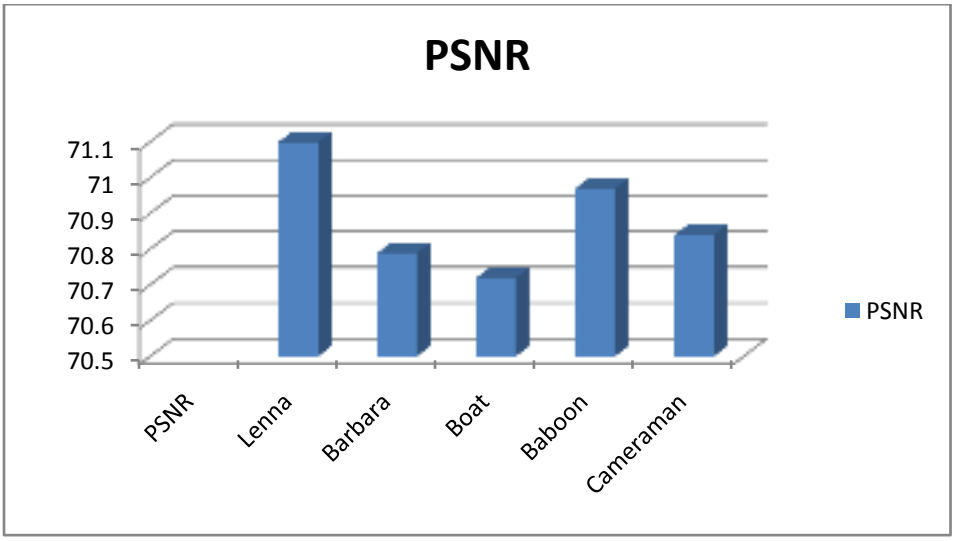
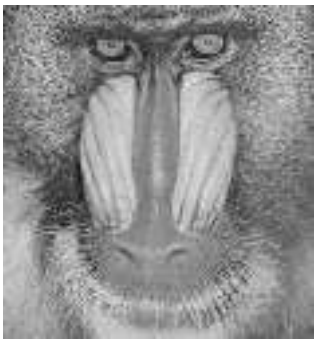



**Figure 10:** Overall performance of PSNR

**Mean Square Error (MSE):** The parameter MSE is a square error among the original image and compressed image. Less value of MSE shows less error and high value means high error MSE value has inverse relation with PSNR. MSE is procedure in which the selection is one of that reduces the sum of square error of MSE can be bias and general.



a) Original image

b) MSE=0.0042

**Figure 11**: a) original image b) MSE value of compressed image

**Compression Ratio**: Compression Ratio is defined as the ratio between original image sizes to the compressed image size.

$$CR = \frac{\text{Original Image Size } (I_1)}{\text{Compressed Image Size } (I_2)}$$

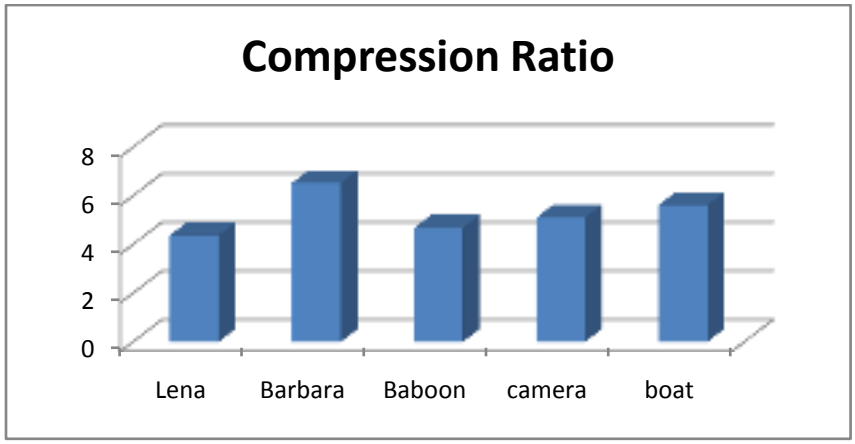



**Figure 12:** Bar chart showing variances in compression ratio

**Execution time:** It is a time needed to execute an image. The technique to be suitable for the processing time its execution time should be small.

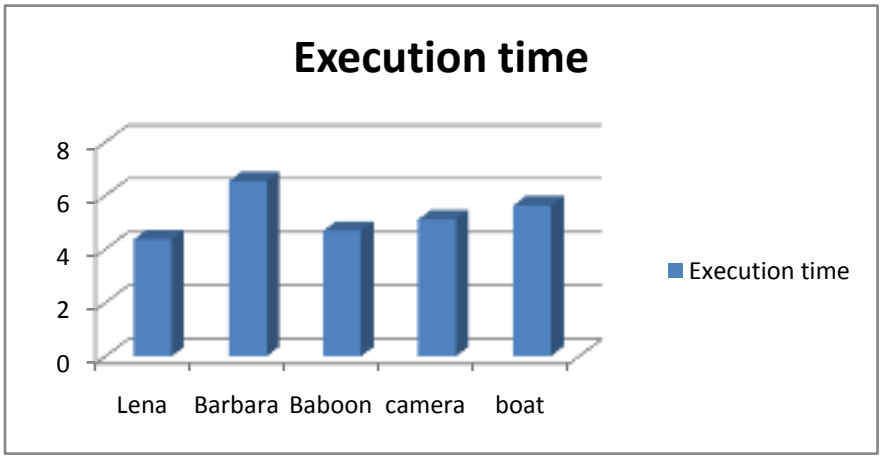



**Figure 13**: Variances of Execution Time

Below Table 4 showing results of parameters PSNR,MSE, CR,ET of images ( Lenna, Barbara, Baboon, camera, boat) of size 512x512 bit gray scale image . all results are presented for level of decomposition 2 and number of principal components is only 80. Table

4 shows that as PSNR increase quality will also increase and there is reduction in MSE values also. Reduction in MSE shows that there is smaller error in reconstructed image. All these factors can view as strong parameters in hybridization of image.

| **Images** | **PSNR** | **MSE** | **CR** | **ET** |
|---|---|---|---|---|
| Lenna | 71.1002 | 0.0050 | 13.2156 | 4.3750 |
| Barbara | 70.7960 | 0.0054 | 12.5069 | 6.5313 |
| Baboon | 70.9707 | 0.0052 | 11.1755 | 4.6875 |
| cameraman | 70.8420 | 0.0054 | 13.9535 | 5.1094 |
| Boat | 70.7267 | 0.0055 | 9.9365 | 5.6250 |
| Peppers | 72.82 | 0.0034 | 10.01 | 5.3125 |

**Table 4:** Results of quality parameters for proposed technique

## 4.2 Comparison with existing technique

The proposed method hybridization of PCA and multilevel 2D-wavelet decomposition has been implemented on several images and matching PSNR is calculated for every image. Existing technique involves PCA and wavelet difference reduction method. Comparison with existing technique results that existing method have to use principal component upto 180 but in proposed methodology we have to use only PC upto 80 with level of decomposition but we get better quality as comparison with existing method. In existing methodology only two parameters are there but in proposed methodology we work on two more parameters. Only two parameters are not enough to decide performance of technique Test images are Lenna, Barbara, camera, boat, baboon of size 512x512 all are 8 bit gray level image.

Table 5 and table 6 shows the comparison result between existing techniques, Increment in level also effect in quality of image. Test images used for comparison are in figure 15.

| **Images** | **Existing Technique** | **JPEG 2000** | **Proposed technique** |
|---|---|---|---|
| Lenna | 40.67 | 39.98 | 71.10 |
| Barbara | 41.03 | 40.27 | 70.79 |
| Baboon | 31.77 | 30.38 | 70.97 |
| Camera | 37.82 | 35.10 | 70.84 |
| Boat | 41.23 | 39.32 | 70.72 |

**Table 5:** PSNR values for decomposition Level=2

| Images | Existing technique | Jpeg 2000 | Proposed technique |
|---|---|---|---|
| Lenna | 38.63 | 32.98 | 74.20 |
| Barbara | 39.43 | 36.21 | 73.12 |
| Baboon | 31.36 | 20.06 | 72.66 |
| camera | 35.89 | 29.10 | 74.86 |
| boat | 39.91 | 34.49 | 70.72 |

**Table 6:** PSNR values for decomposition Level=4

Figure 14 and Figure 15 shows the graph chart of PSNR values of new proposed technique comparison with existing technique.

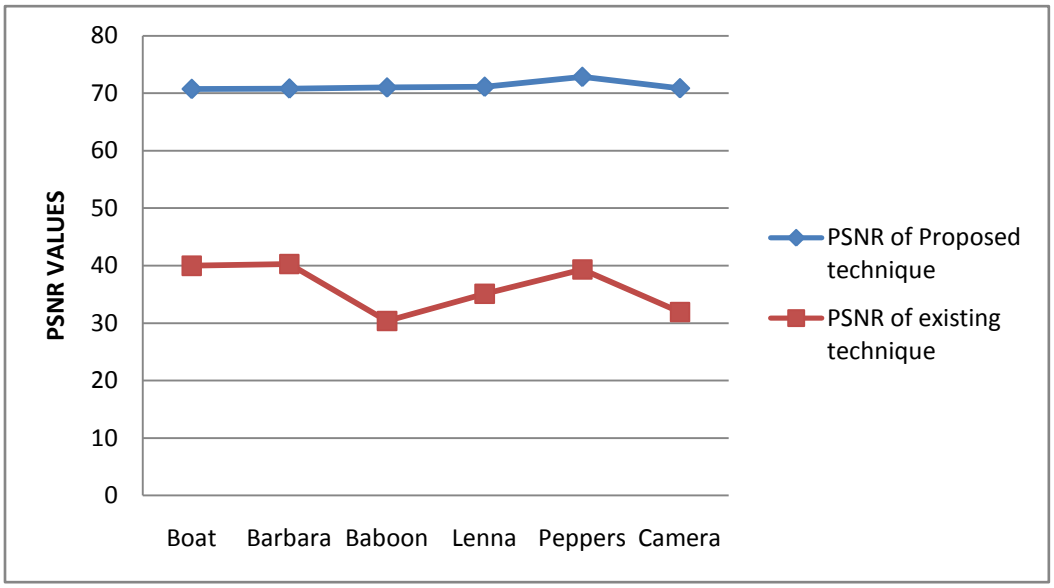



**Figure 14:** Comparison of PSNR values with existing technique

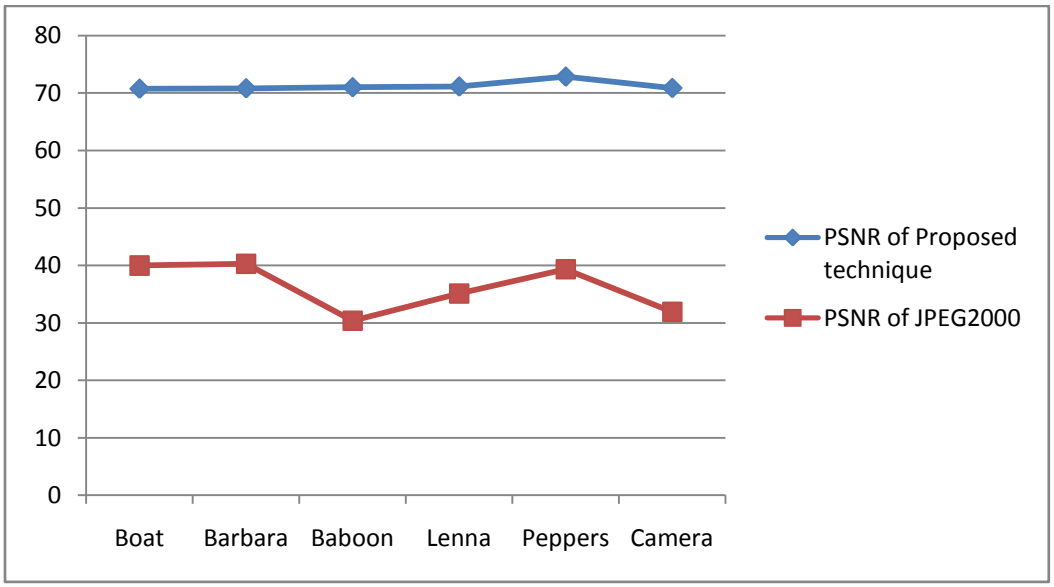



**Figure 15:** Comparison of proposed technique and JPEG2000

Below Figure 16 is a gray scale image which will given as a input image in proposed technique. The proposed technique also works for color images but firstlyc onvert it into gray level 8 bit images.

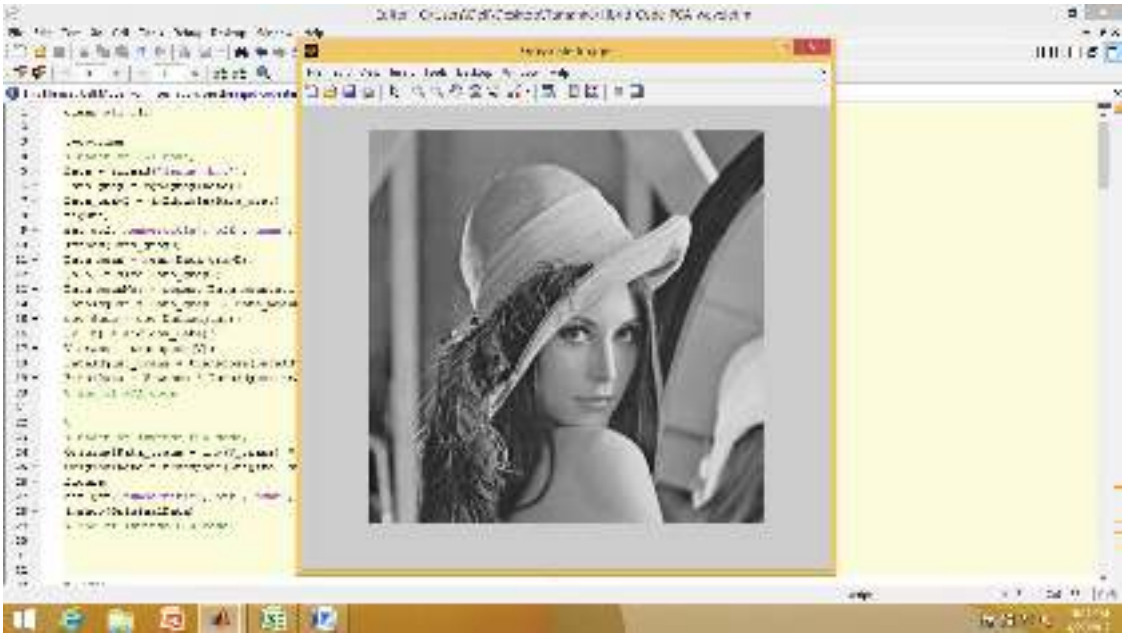


**Figure 16:** Input Gray scale image

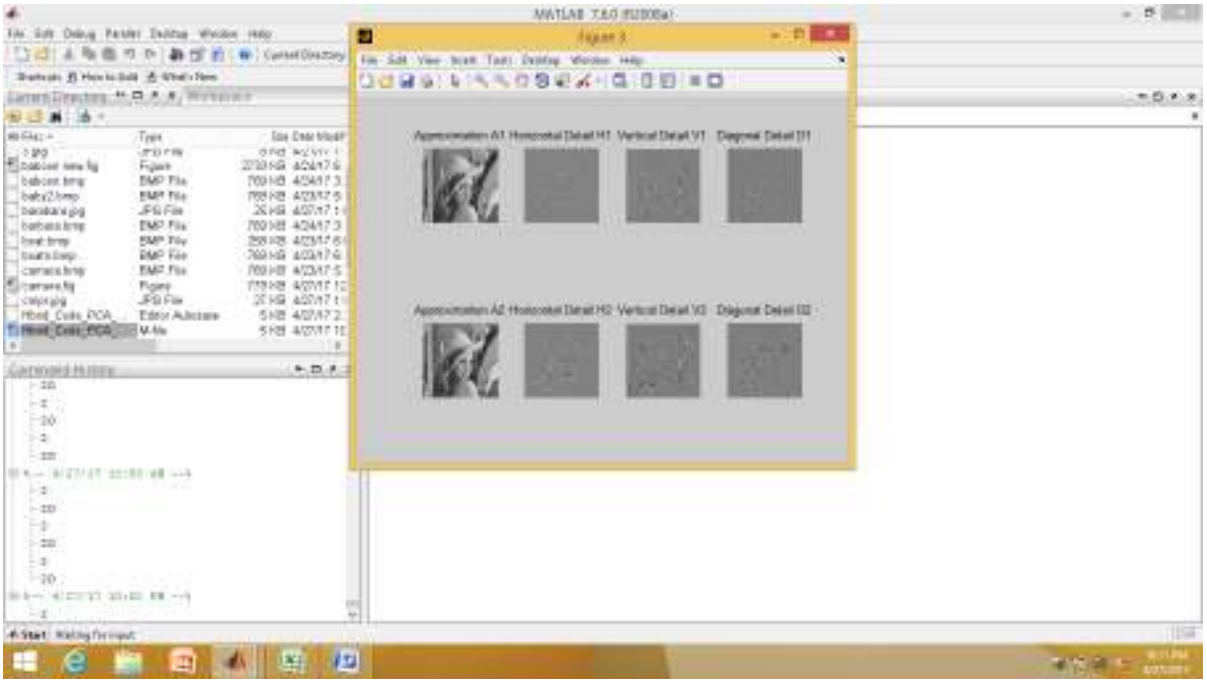


**Figure 17**: Level of Decomposition

Below figure 14 shows the results of implementing proposed hybridization and the algorithm is implemented Camera image of size 512x512.

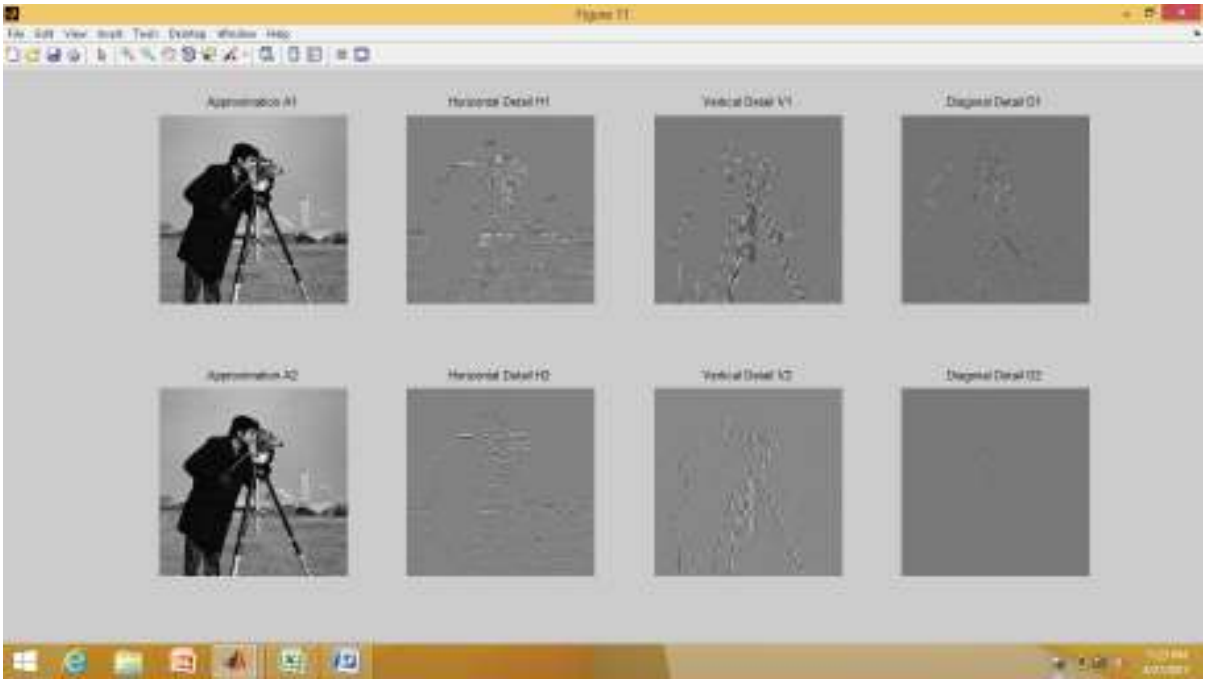


**Figure 18:** Compressed image (camera) after proposed technique

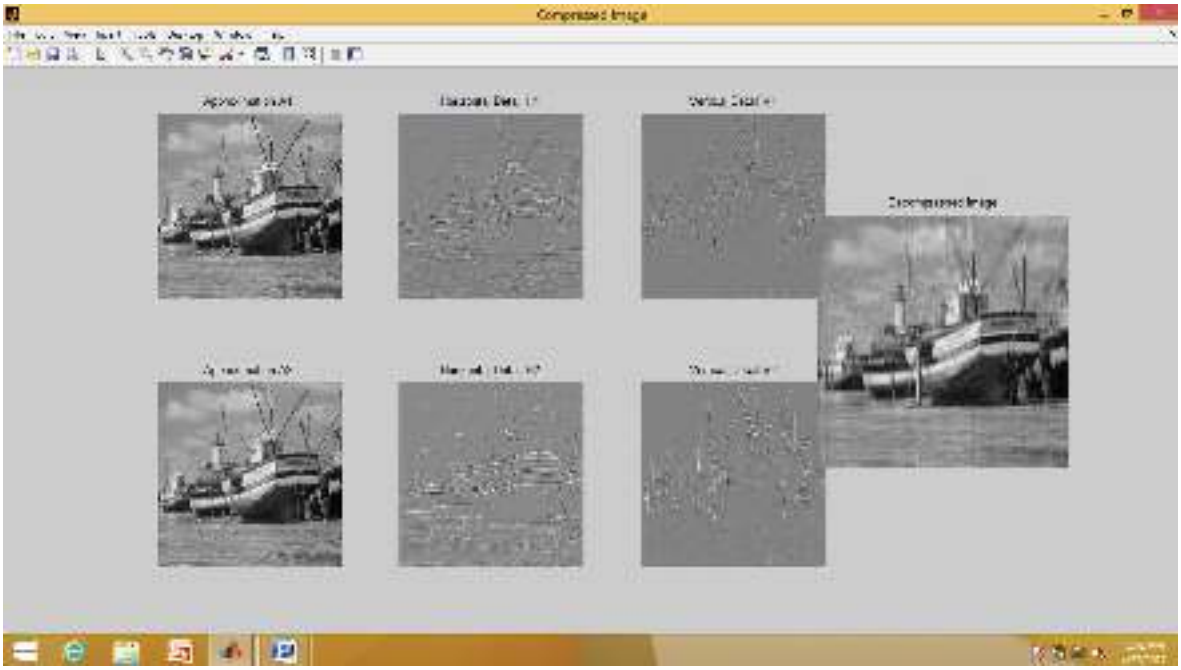


**Figure 19**: Levels of decomposition

Below figure 20 shows the reconstructed Figure (Baboon) at decomposition level= 2 and principle component = 80 are used which shows that there is very less difference in original image and reconstructed image.

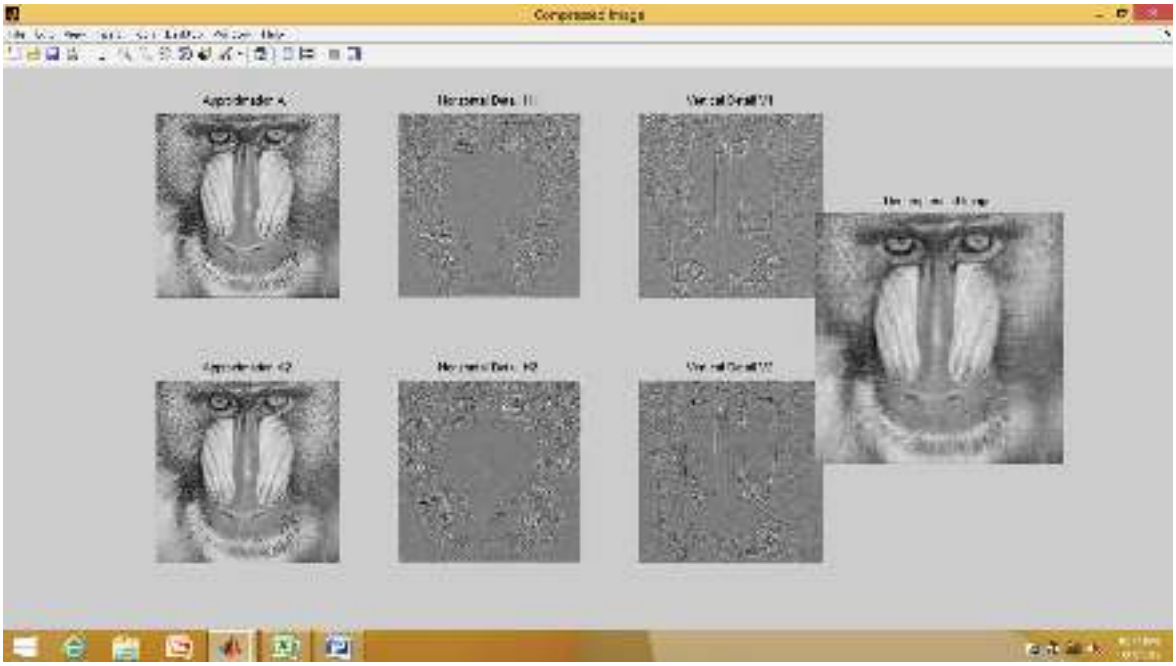


**Figure 20:** Decompressed Image (Baboon)

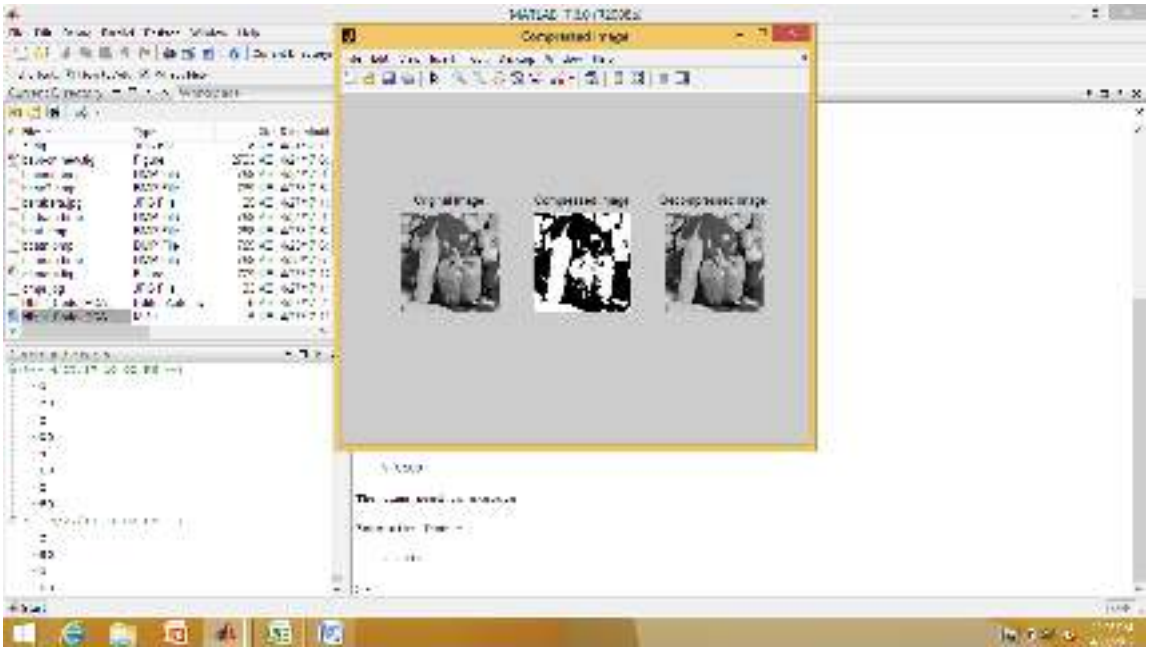


**Figure 21:** Decompressed image (peppers) for PC's=80

Below Figure 22(cameraman) and Figure 23(Boat) shows the image compression after implementing proposed technique both are gray scale images size 512x512.

**Figure 22:** Image compressed with proposed technique

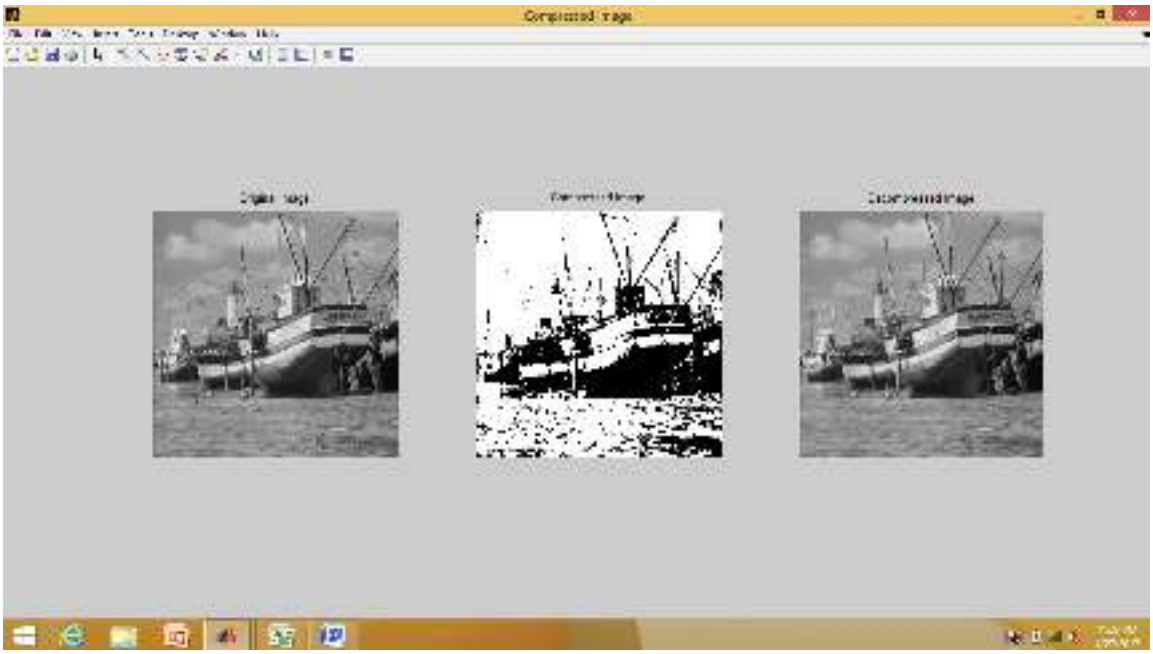


**Figure 23:** Image (boat) compressed with proposed technique

# CHAPTER 5

# CONCLUSION AND FUTURE SCOPE

In this paper, PCA and 2D-wavelet based image compression technique has been implemented. Image compression is use to reduce the number of bits require to represent an original image, which can be achieved by removing redundant and visually unimportant information from the image that will not visible to human eyes. Removing these redundancies from the image using compression techniques will reduce size of image.

The proposed method use level of decomposition property of 2D-wavelet technique and reduction property of PCA. 2D-wavelet introduces level of coefficients for image quality and compression. Multilevel 2D-Wavlet helps in both compression ratio and image quality. Wavelet transform is use to evaluate mathematical methodologies. Wavelet transforms are sampled by additional wavelet transforms in DWT. The main application of wavelet transform is temporal resolution. 2D wavelet are used for image many image processing applications. Wavelet decomposition level is based on two concepts of filters a) Low pass filters b) High pass filters. This decomposed into four distinct frequency bands low pass band (LL), diagonal (HH) high pass bands, horizontal (HL), vertical (LH). An image is a visual representation of something. An image is a picture that has been created or copied and stored in electronic form. An image can be described in graphics. An image map is a file containing information that associates different location on a specified image. PCA is a non parametric technique of extracting useful information from large data sets. Principal component analysis (PCA) has been widely used in image processing like image compression and image classification techniques. PCA is stastical technique also work for application such as face recognition. Principal component analysis work as a vector space transform which is use to reduce multidimensional image data set to less dimensions for examination.

The introduced parameter MSE helps in to determine error in two ways subjective and objective. Subjective like only through eyes and objective using error parameters. It is obvious that if there is less error in compression results the image improve better. The results

clearly explain that the proposed methodology performs much better as compare existing technique in case of quality (PSNR) of reconstructed image but the achievement in compression ratio is not much. The parameters which are introduced helps to decide that which technique work for which applications. In future we will work to improve compression ratio. The proposed technique will also implement on color images and on the images containing critical information images like medical images, industrial design and satellite images due to greater quality value of proposed technique.

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