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Innovative Hybridization for Image Compression using PCA and Multilevel 2D-Wavelet

Tamanna, Neha Bassan

Abstract*: In modern era, the utilization of multimedia artifact grows gradually more, contributing to inadequate bandwidth of network and storage of memory gadgets. For that reason the concept of image compression becomes more and more considerable for reducing the data redundancy to accumulate more hardware space and transmission bandwidth. Image compression is valuable because it helps decrease the use of different resources mainly hard disk storage .Images are generally viewable representation of matrices and not compressed image use outsize number of memory for storage. In this paper we briefly describe different image compression techniques, an analysis different implementations and Finally the innovative method for image compression by using principal component analysis (PCA) and multilevel 2D-wavelet decomposition based method has been implemented. The main objective behind the hybridization of these two techniques are to use advantages of both compression techniques at one platform.

Keywords : Cosine Transmission ,Wavelet compression, JPEG, Execution Time, Peak Signal Noise Ratio

I. 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. In the raising growth of software applications results in increment of data such as photos(images), which takes large storage space where as uncompressed image takes large space for storage and require high network bandwidth for transmission of an image. Image compression mainly involves in removing redundant and unwanted information without any significant effect on the quality of image. Compression of an image increases file transfer speed and decrease file storage space so that the cost of associated hardware reduced. There are two types of image compression lossy and lossless. Here lossy compression in which compressed image, not exact copy of original image. There is loss of information in this type of compression and it is suitable for photographic images, where pixel information does not matter. In lossless compression the compressed image is exact replica of original image and there is no loss of information. During lossless compression the image compression rate is less as compared to lossy compression.

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* Correspondence Author
Tamanna*, CSE, Lovely Professional university, Jalandhar, India. Email: Tamannasharma955@gmail.com.
Neha Bassan, CSE, Lovely Professional university, Jalandhar, India Email:NehaBassan10@gmail.com.

II. EXPLANATION OF IMAGE COMPRESSION TECHNIQUES

The aim of image compression is to keep storage space and to minimize transmission time for image information. The main aim to achieve good compression ratio while maintaining its image quality. In this section introduction of different image compression techniques has been explained.

A. Discrete Cosine Transformation

Image compression takes the benefit of sparse representations where lot of information is packed into less number of coefficients. These type of representations are achieved by these transformations Discrete cosine transformation (DCT) Discrete wavelet transformation (DWT), Karhunen loeve transformation (KLT) and Principal

B. Principal Component Analysis

The main aim of image compression with help of PCA to capitalize an effective illustration of image value by reducing dependency between image data . This method consists of transforming highly correlated variable into less correlated variable by applying transformations. PCA helps in image ideality but less compression ratio value, so that several techniques have been implemented by using PCA to improve compression ratio of an image. Discrete wavelet transform (DWT) in which wavelet are discretely sampled to achieve image compression [2].

C. Discrete Wavelet Transmission

DWT contained both time and frequency domain. Wavelet transform is use in image processing e.g edge detection, noise removal and image compression. A wavelet anatomy has been applied on whole image instead of sections at a moment[3].Bi-orthogonal is referring as bior wavelet and bi-orthogonal are mostly known as an alternative term of orthogonal specifically dealing with each scaling and wavelet function, these both scaling function which also create dissimilar several resolution scrutiny. While using these different wavelet functions in examination and results of case study chart show that bior1.1 and bior1.3 achieves good compression ratio as well as better PSNR image compression[4].

D. Joint Photographic Experts Group(JPEG)

Above named technique has known as very famous technique for image compression approach. While to apply above method an original image is partitioned into 8x8 blocks then apply above explained discrete cosine transmission scheme.

III. Related Work

To a great extent of work on domain image compression has been organized by various research workers. A brief analysis of outstanding implementations from extant writing material is discussed in this section.

A. WDR based on image compression and PCA

In this paper author proposed a new wavelet based wavelet difference reduction technique abbreviated as (WDR) technique which further use principle component analysis (PCA) for image compression. The aim of combining these techniques are that WDR helps in high compression ratio and PCA provide high quality. PCA technique is also known as KLT named after Kari Karhunen, Michael leove or hoteling transform. The proposed methodology which is a hybridization of PCA and WDR is further compared with JPEG2000 [6].

B. Block based implementation of PCA

In this paper PCA is applied to every block of original image. After this step PCA is applied to block to row. Every row information is combined into a row then we apply PCA on each block and transformed in to matrix. Whenever there is an equal block size as well as compression ratio quality will also outperform in PCA. Compression ratio will arrive at zero if we use all principle components and compression becomes one if we use less principle component. With the use of above proposed technique compression ratio can achieve upto 90% with no loss of quality [7].

C. Image compression using PCA and DWT

In this paper author combined two approaches named as PCA and DWT. The original image is firstly decompressed by using discrete wavelet transformation (DWT) Further principle component analysis method is implemented on HL, LH frequency with sub band images. The proposed method provides compression by preserving the needed critical boundaries or contours. It can be preserved doing image compression so that minimum information reduce in image compression while using the thresholding process [3].

D. Image compression using wavelet families

In this paper author scrutinize basic concepts about wavelet including wavelet transformations, discrete wavelet transformation, principles of image compression and image methodology. The main point of doing this analysis is to select suitable method of transformation to perform compression on gray scale image while maintaining the ideality of original image. Wavelet families include haar, Daubechies, Biorthogonal, symlets and coiflet name also applies on original image while their respective qualitative outcome are presented in various terms of quality measures PSNR and CR and Mean square error values. Its wavelet transform and its inverse can be use for inverse transform [8].

E. Clustered Blockwise PCA

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 to implement on PCA method to visible data which consume benefits of spatio-temporal correlation and another frequency variations which normally locate in visual image data. In this method not firmly working on whole method and apply PCA to whole data firstly partition the data into blocks and then perform PCA on each one and combine into a set of blocks and group them together. As a result we can use PCA to control large data elements. The introduced method is applied on videos. As future work author examine methodology for calculating optimal and temporary block perimeter that allows modulating diagonally through the data volume. This problem remains there which reduce the availability of practical algorithms [9].

F. 2D-Discrete Wavelet Transformation

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. Where wavelets are also good property for computer graphics. Wavelet based compression provide optimization in image and better compression ratio. Quantizer also help to decrease value of bits which store altered factor. Quality of compressed images is evaluated using parameters Peak signal noise ratio, Mean opinion score and Picture Quality score. 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 [10].

IV. HYBRID COMPRESSION USING PCA AND MULTILEVEL 2D-WAVELET

Principal component analysis method stastical formulation applied on the reduction of data dimensionality. PCA allows the recognition of standards in image data in such a way that their differences and similarities identified. PCA is a lossy compression type due to dimension reduction [11].

A. Image Compression Using Principal Component Analysis (PCA)

PCA is not parametric procedure of extracting useful content from huge data sets. This technique has been broadly used within image processing like image compression and image classification techniques. The weakness of PCA will be reduce 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 there is memory required to store raw data which will work same as applying PCA for each and every PCA is statically 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 [12]

B. Multilevel 2D-Wavelet Transformation

Multilevel 2D-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. First is quantization and then entropy coding. Quantization involves reduce the number of possible values of a quantity and possible pixels values to represent an image. The image is presented during appropriate basis set and the result will obtained as sparse coefficients matrix. Transformation domains are lossy compression methods. The examples of these methods are wavelet transformation and Principle component analysis(PCA).

Entropy coding is a way for representing quantized image 2D- wavelet and can use for many image processing applications [13]. 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 LL, diagonal HH, vertical LH and horizontal HL. In multi wavelet transform, the transform will be implemented by using multi wavelet functions and scaling functions [14].

C. The Proposed Algorithm

In this paper hybridization of two techniques- Principal Component analysis (PCA) and multilevel 2D-wavelet has been implemented. The main objective behind this hybridization is to use advantages of both methods.

PCA improves the image quality but there is a loss of information (lossy method due to dimension reduction) and multilevel 2D-wavlet helps in quality as well as compression ratio. Thus by applying both methods there is very less effect in quality of an image. Even the loss of information in an image will not perceptual viewable to human Visual System (HVS).

This proposed technique has been implemented on various images of size 512x512 with 8-bit gray level representation. MATLAB tool has been used for implementation.

The algorithmic rules for the proposed hybrid method are described as below:

1) Read the grayscale insert image from computer (Image dimension 512x512).
2) Set level of decomposition (require in 2D-wavelet).
3) Apply 2D-WT using various wavelet and decompose an image from decomposition level 1 to n- level.
4) Extract the level 1 coefficient which is A1, V1, D1, and H1.
5) Set the threshold value.
6) Calculate Peak signal noise ratio (PSNR), Mean square error (MSE), Execution time (ET) and compression ratio (CR).
7) Evaluate the results you have calculated to analyze performance of hybridization techniques.
8) Repeat steps from step 2 to step 6 over again for different results.

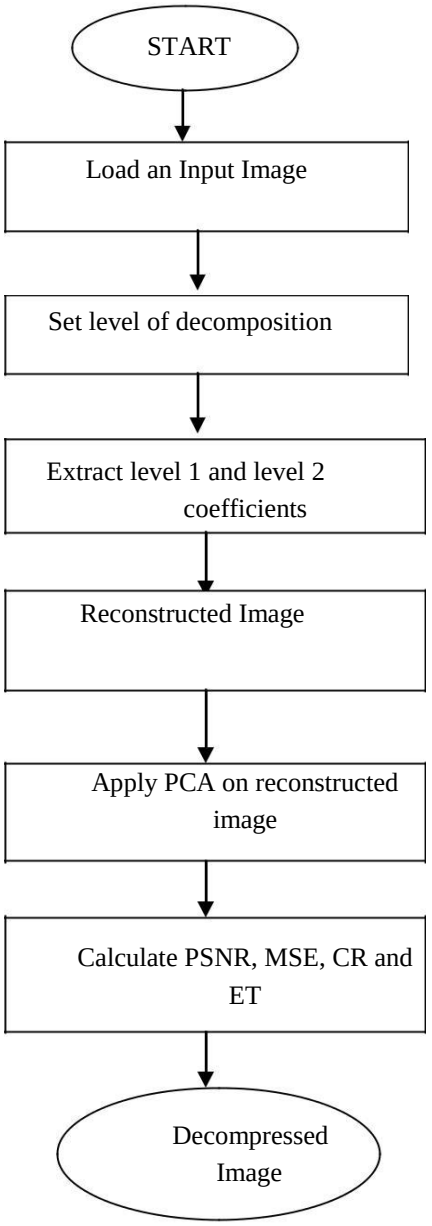


Figure 1: Flow chart of proposed methodology

V. EVALUATION RESULTS AND DISCUSSION

Recommended hybridized method is tested on various data images (Lenna, Barbara, boat, camera and Baboon) and related PSNR values are calculated for each image. All of the above images of size 512x512 have 8 bit gray level perception.

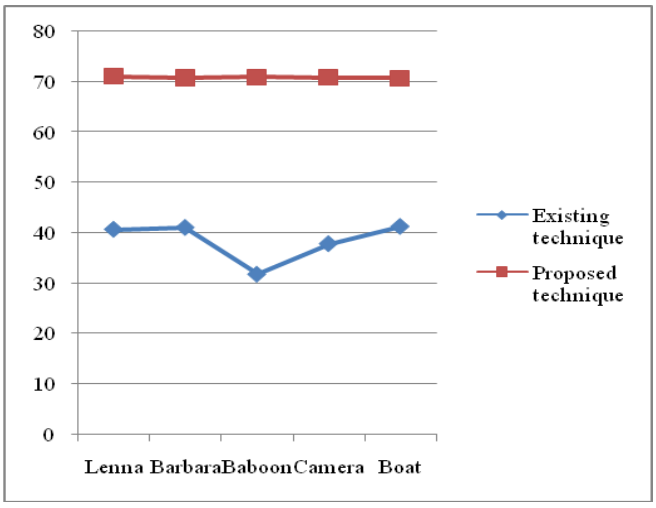
Table 1 as well as “Fig. 1” shows the comparison between existing techniques (hybridization of PCA, WDR and JPEG 2000).

Results shows that proposed hybridized technique has better PSNR results. In the proposed technique there is increment in number of principal component which has increase in PSNR values and decrease in CR value.

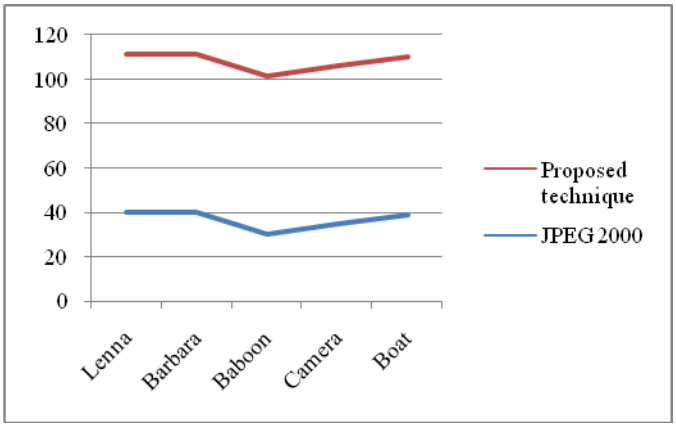
Below are the PSNR results for decomposition level=2 and level=4.

Table-I:Comparison of Existing Technique And Proposed Technique

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
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



Graph 1:The graph chart shows varying PSNR values of exiting technique and proposed technique



Graph 2: The graph chart shows varying PSNR value of proposed technique and JPEG 2000

VI. PERFORMANCE PARAMETERS

The innovative The image quality can be identifying objectively and standards methods are there. The name of those measuring parameters are peak signal noise ratio (PSNR), Compression ratio (CR), Mean square Error(MSE) and Execution time(ET) are there[15].

1. *Mean Square Error (MSE):* MSE is error metrics applied on different compression transformations.

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

X (a, b) is an image, X' (a, b) is a compressed image and where N is the number of pixle in available image

2. *Execution Time (ET):* The execution time is a time needed to execute an image. The execution time can be calculated in seconds

The innovative hybridized compression technique has been evaluated based on Parameters which are explained below.

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:

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

Where MSE is mean square error explained below

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

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

VII. CONCLUSION

Image compression using hybridized method provide superior quality image. In this paper an innovative technique for image compression has been implemented.

Image compression can be achieved by removing redundant and visually unimportant information from the image. Removing these redundancies from the image using compression techniques will reduce the image size while maintaining its quality. In this paper the quality of image is also verified by using different evaluation parameters. In future we will work on compression ratio which is one the image quality evaluation parameter. The hybridized technology will also implemented on medical images, industrial design and satellite images.

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AUTHORS PROFILE

Mrs. Tamanna has completed M.tech from LPU Phagwara. Her area of specialization is database. Currently she is working as an assistant professor. She has completed her B.tech from PTU Jalandhar. Her areas of interest include Image compression, database and IOT.

Ms . Neha Bassan working as assistant professor in LPU Phagwara Jalandhar. She has an experience of 5 years in teaching . She has completed her M.tech from GNDU. Her areas of interests include image processing ,computer networks and wireless technology. She has published many papers in national and international journals.