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Comparatively analysis of Wavelet Based Image Compression & Sub-band Coding

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Abstract:-Wavelet-based image compression has been the subject of recent study. We suggest a compression method based on modifying the original EZW coding in it. We strive to eliminate less significant information in the image data in this lossy technique in order to achieve additional compression with little impact on output image quality. In each level, the algorithm calculates the weight of each sub-band and determines the sub-band with the least weight. Each level's smallest weight sub-band, which has the least effect during image reconstruction, passes through a threshold process to remove low-valued data. During the experiment, several threshold settings were used to determine how they affected the compression ratio and reconstructed image quality. As a result of the proposed strategy, the compression ratio is increased even more.

The rapid advancement of computing technologies has resulted in a demand for digital photographs. The expense of manipulating, storing, and transmitting these photos in their raw form is prohibitively expensive, slowing transmission and increasing storage costs. A quick review of wavelet transform theory is given in this study, with filters used as examples to demonstrate multiresolution analysis. The advantages of the Fourier transform are studied, and numerous conclusions are drawn. The pyramid algorithm is also discussed, as well as several wavelet aspects in image data compression. image quality isn't harmed in the process.

Keywords:-Image compression, Wavelet image Compression, Embedded Zero coding, Sub band Coding.

I.INTRODUCTION

Wavelet-based image compression has been the subject of recent study. We suggest a compression method based on modifying the original EZW coding in it. We strive to eliminate less significant information in the image data in this lossy technique in order to obtain better compression with less effect on image quality. The algorithm that calculates the weight of each sub-band and determines the sub-band with the lowest weight at each level. This minimum weight sub-band at each level, which has the least effect during image reconstruction, is subjected to a threshold process to discard data with low value. During the experiment, several threshold settings were used to determine how they affected the compression ratio and reconstructed image quality. The method that has been proposed is The rapid advancement of computing technologies has resulted in an increased need for digital photographs. The expense of manipulating, storing, and transmitting these photos in their raw form is prohibitively expensive, slowing transmission and increasing storage costs. A quick review of wavelet transform theory is given in this study, with filters used as examples to demonstrate multiresolution analysis. The advantage of the Fourier transform is that it can be discovered and numerous results can be produced. The pyramid algorithm is also discussed, as well as several wavelet aspects in image data compression.

II. IMAGE COMPRESSION

Image compression is a method of compressing an image and storing or transmitting it with fewer bits. These days, the two most used methods of image compression are the Discrete Cosine Transform (DCT), which is based on the procedure of wavelet transforms, and the Discrete Cosine Transform (DCT), which is based on the procedure of wavelet transforms. JPEG, the most widely used image compression technique, improves picture compression by applying DCT to the image, whereas wavelet transform approaches often utilise discrete wavelet transform (DWT).

This wavelet method has begun to be an effective coding method for still image compression as a result of huge improvements in wavelet compression. This compression technique compresses the image utilising the following techniques: Wavelet transform, zero-tree coding, and entropy-based coding are the three methods. The Wavelet transform breaks down a picture into several multi-level subbands and reconstructs the original image from these subbands. Two-dimensional wavelet filters are used for this multi-level subband coding. For multi-level decompositions, some essential filters are Haar and Daubechies filters, which are widely used filters. Filter selection is

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critical for efficient coding, hence the proper result should be displayed. The wavelet transform is used to divide a sub-band into four higher-level sub-bands shown in fig1.

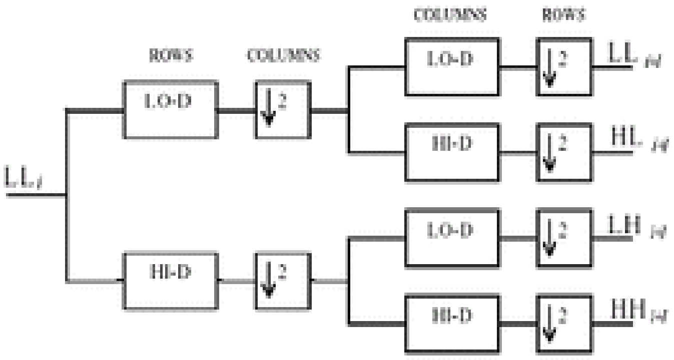

Fig .1 SUB BANDS

In 1993, the commonly used approach Zero-tree Wavelet (EZW) was introduced in wavelet coding. Its main focus is on dependencies between sub-bands dissected by wavelets, and it employs zero-tree to achieve high level and superior picture compression. As a result, the coefficients in sub-bands are scanned and their values are compared to a decreasing threshold for approximation quantization. The use of variable length coding should result in a higher compression ratio. This is dependent on EZW data that has been coded. Another method, such as adaptive arithmetic coding, is often employed for additional compression at the expense of complexity and calculation time.

III. WAVELET IMAGE COMPRESSION

Image compression can be accomplished with a variety of algorithms, including transform-based approaches, vector quantization, and sub-band coding. The image selection is based on a compression method that is based on fine receivable compression ratio criteria and reconstructed image quality. Wavelet transformation is an emerging field for picture compression that is based on coding and has a high coding efficiency. JPEG-2000, a new wavelet-based image compression method, has been standardised recently. indicating that future compression systems will utilise the wavelet compression technology This paragraph gives an overview of wavelet image compression before delving into the details of an Embedded Zero-tree wavelet transform method coding scheme.

- **Wavelet Transform:** Wavelet Transform generates a multi-resolution image representation. It has a higher energy contracting feature, which is useful for reducing redundancy in images and achieving compression.Two-channel wavelet filters can be used to implement the Discrete Wavelet Transform (DWT). The 2D-DWT Input image is scanned horizontally first, then passed through low-pass and high-pass decomposition filters for an image. The deconstructed data is then vertically sub-sampled to provide low and high frequency data in the horizontal direction. After that, the filtered output data is

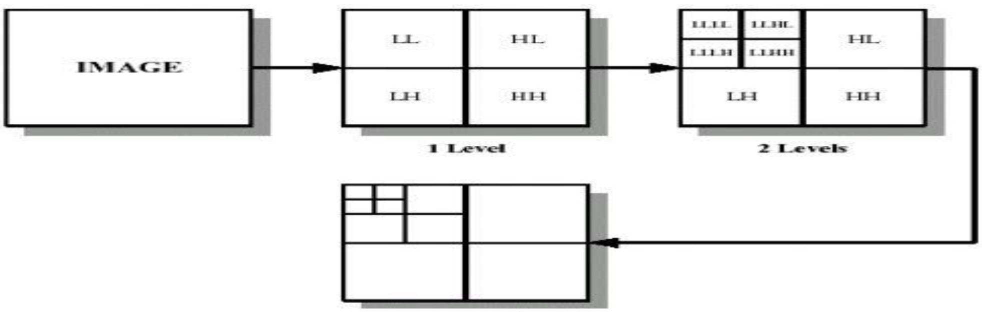

Fig .2. DWT

The image's filtered output is scanned vertically, and the filters are applied again to generate distinct frequency sub-bands. Following that, in the horizontal direction, the resultant data generates sub-bands LL, LH, HL, and HH, each one-fourth the size of the original image. The low frequency sub-band LL represents a down sampled version of the original image with limited resolution, whereas higher frequency sub-bands provide more precise information about the

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image in horizontal, vertical, and diagonal directions. After finishing one level of image processing, the image is decomposed by applying 2-D DWT to the just presented LL sub-band once more. Multiple degrees of transformation were obtained as a result of this technique, with only a few low frequency transformations.

- **Embedded Zero-tree Coding** : The EZW encoder quantizes the coefficients after performing wavelet transform on the input image to provide an embedded representation of the image. The link between higher and lower level coefficients is defined by EZW. This coding method is carried out in two stages: (1) Pass to the dominant player (2) Pass for a subordinate.

Wavelet magnitudes are compared to wavelet coefficients with a given threshold value T in the dominant pass. A two-bit symbol is used to define the position of all coefficients as the scanning progresses from low to high spatial frequencies. The threshold values for the positive significant (POS) and negative significant (NEG) coefficients are chosen from the highest power to the peak wavelet coefficient value.

If the wavelet coefficients are insufficient, it is coded separately as an isolated zero (IZ). Otherwise, the coefficient is generated as a single-symbol zero-tree root (ZTR). The ZTR's incorporation improves coding efficiency. The subordinate detects the coefficients that are refined using the SAQ approach (Successive Approximation Quantization). It uses either a zero or a one to add a significant bit to each of the coefficients. The method is repeated once all of the coefficients have been coded for a certain threshold value T. Overall, the encoder transmits an embedded bit stream that can be further compressed using the EZW approach based on threshold magnitude.

III. PROPOSED ALGORITHM

Researchers are very interested in the development of EZW (Embedded Zero-tree Wavelet) image coding. It is the most extensively used wavelet-based compression algorithm in a variety of applications. The focus of this work is on the EZW algorithm, and it offers an expansion of it. Using the wavelet transform, the image is first decomposed into sub-bands. The resulting data is then preprocessed before zero-tree compression. Figure 3 depicts a block diagram of a wavelet-based image coding technique.

The major goal of this new approach is to increase an image's compression ratio while minimizing loss during reconstruction. This approach focuses on the compression pre-processing stage, removing some of the unnecessary data from modified images that contribute little to image reconstruction but consume more bits during compression. It takes advantage of the tradeoff between compression ratio and reconstructed image quality by removing some of the least relevant image data in order to achieve even more compression with only a minor loss in image quality.

The approach is based on the notion that, when compared to sub-bands with greater values, sub-bands with low values have less effect on output. The higher the values, the more dependent that sub-band is, and the lower the numbers, the less dependent that sub-band is. The LL sub-band coefficients depict a low-resolution image, whereas high frequency sub-bands contain detail sub-bands in each direction. These three sub-bands contribute less to picture reconstruction since their coefficients are generally zero (or close to zero), with only a few large values corresponding to image edges and textures. In order to achieve additional reduction, we present an approach for reducing the least important data. Keep the high-value coefficients in your possession; the lower-value coefficients should be avoided.

To do this, we first identify the sub-bands with the lowest values, and then use a threshold value to filter out low-valued data that contributes to image reconstruction. To generate one minimum valued sub-band for each level, the algorithm employs a weight calculation approach. Each sub-weight band's is calculated by summing the absolute values of all of the sub-coefficients. band's The one with the smallest weight at each level (LHi, HLi, and HHi) is designated as the minimum weight sub-band. For each level, one minimum weight sub-band is obtained.

. To demonstrate the effect of compressed output and rebuilt image, we employed varied threshold settings in our studies. The threshold data is then compressed using zero-tree coding. Higher compression ratio with less loss in decoded PSNR is achieved by reducing low valued significant coefficients in minimal weight sub-bands. The results reveal that this approach is more efficient at the cost of a minor reduction in image quality.

V. EXPERIMENT RESULTS

The proposed algorithm was integrated into software, and results from computer simulations were obtained. For the experiments and results, three different 256x256 8-bit grayscale images, cameramen, were used. In terms of compression ratio and reconstructed PSNR, experiments have demonstrated that three-level wavelet decomposition produces the greatest results. As a result, Daubechies 9/7 biorthogonal wavelet filters were used to breakdown the input image into three-level wavelet transforms. After that, the wavelet converted data was preprocessed.

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Each detail sub-weight band's was calculated to determine the lowest weight sub-band in each level. To compute sub-band weight, the absolute values of all the coefficients in a sub-band were summed together. The sub-band with the least weight was designated as the minimal weight sub-band out of all three sub-bands in each level.
During tests, the diagonal detail sub-band (HH) was found to be the minimal value sub-band the majority of the time, indicating that the diagonal sub-band contributes the least to picture reconstruction. Only a few times was a horizontal (HL) or vertical sub-band (LH) indicated as minimal. In order to accomplish further compression, a lossy threshold procedure was applied to the minimal weight sub-band to remove low valued data. A threshold value of 2 and 5 were employed individually in the studies to exclude coefficients equal to or below them..
After the preparation stage, the embedded zero-tree coding algorithm was used to compress the data. The proposed algorithm compressed relevant pixels using a z-scan coding approach, starting at the highest level and moving down in a z-fashion. In the end, adaptive arithmetic coding was applied for additional compression, but at the cost of complexity and calculation time.

The coded data was used to reconstruct the image, and the image PSNR was determined. This method was used to compress cameraman photographs, and the results of the compressed output and reconstructed image were examined. As the threshold is raised, the PSNR of the reconstructed image decreases as the compression ratio increases. In general, a low-valued threshold outperforms a high-valued threshold with a minimal loss in PSNR. The approach used a threshold on the minimal weight sub-band, resulting in less coded bit stream data (high compression) and some PSNR loss during reconstruction.
PSNR represents reconstructed PSNR in decibels, while bytes represents compressed output in bytes (dB). HL stands for horizontal, H for vertical, and HH for diagonal sub-band. These findings suggest that the updated approach provides more compression at the expense of a little reduction in reconstructed PSNR. Figure 4 shows the wavelet-based compression's various image outputs.

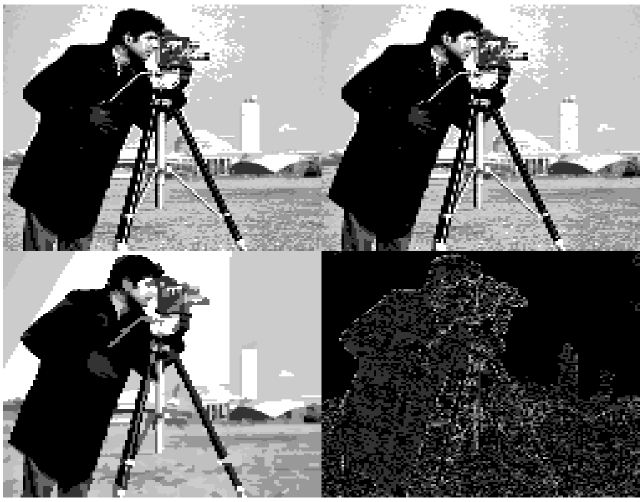

Fig. 3.IMAGE WITH DIFFERENT COMPRESSION

VI .WAVELETS FEATURES FOR IMAGE COMPRESSION

This is a rundown of some of the features of Wavelet-based image compression.
1. The energy compactness of the wavelet transform is retained throughout the transform, i.e. the sum of squares of the wavelet coefficients equals the sum of squares of the original image.
2. Wavelets can give good compression, and they can even outperform JPEG.
3. Wavelet transforms are used to alter and compress the entire image as a single data item, rather than block by block. This ensures that compression error is distributed evenly over the entire image and at all scales.
4. The wavelet transform methods provide integrity at higher compression rates.
5. Transmission and zooming are possible thanks to multiresolution features, which require no additional storage.
6. It is a high-capacity business.
7. Wavelet transformed images can be used to execute a variety of image operations such as noise reduction and image scaling.
8. Scaled sub-bands are created as a result of the wavelet multiresolution.
9.Efficient encoding takes use of this dependency. This is how wavelet transform compression is accomplished.

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VII. SUB BAND CODING

Introduction

Sub-Band Coding (SBC) is a powerful and general approach for efficiently encoding audio signals from any source, making it suitable for music recordings, movie soundtracks, and other similar applications. The best example of SBC is MPEG Audio. This document explains the basic concepts of SBC and addresses some of the challenges that arise when it is used.

Basic Principles

SBC is based on the human hearing system's masking idea. The ears of normal people are extremely sensitive to a wide range of frequencies. The ear, on the other hand, is unable to hear lower energy frequencies that are close by. As a result, the softer frequencies cover the stronger frequencies. The masker refers to the louder frequency.

SBC's main goal is to reduce signal bandwidth usage. Although the outcome will not be identical to the original signal, if the computation is done correctly, human ears will be unable to detect the difference.

Encoding audio signals

The easiest technique to encode audio signals is via pulse code modulation (PCM). PCM, like all other forms of digitalization, introduces noise into the signal. The lower the number of bits used in digitization, the more noise is introduced. Using enough bits is one technique to reduce noise. This results in a signal of great quality, but at a high bit rate (over 700k bps for one channel of CD audio). A considerable number of bits are being wasted by encoding masked sections of the signal.

There are more ingenious ways to digitise an audio signal that save bandwidth. Nonlinear PCM, such as mu-law encoding, is a classic approach. It works similarly to PCM and adds noise that is proportionate to the signal strength. The.au sound file format from Sun is a good example. Our one channel of CD audio would be reduced to roughly 350kbps if we used 8-bit mu-law encoding, which is generally of lower audible quality than the original signal. **A basic SBC scheme**

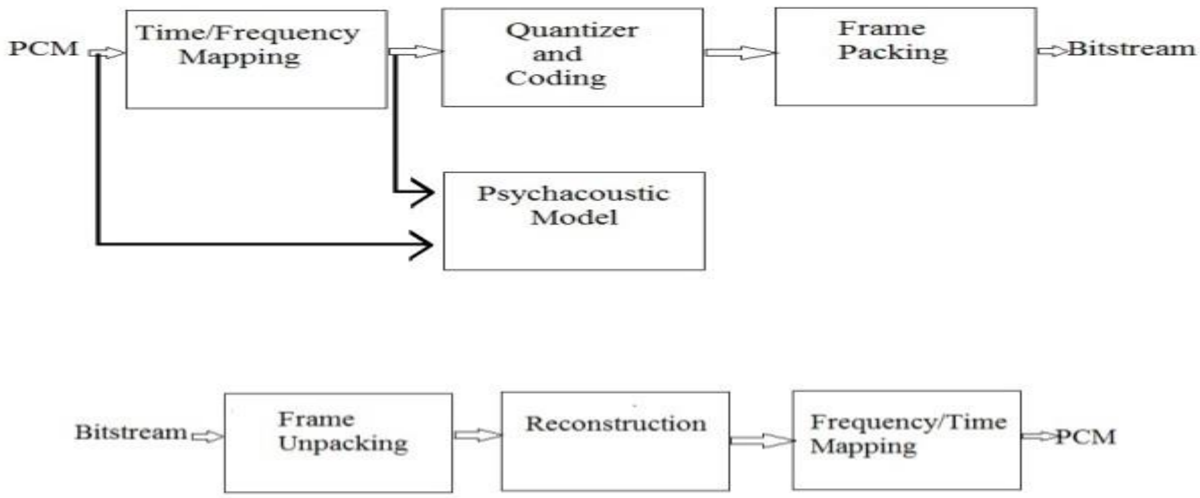

Fig.4. SUB BAND CODING

SBC is an acronym for "Small Business Corporation." The input signal is first decomposed into sub-bands using a time-frequency mapping filter bank. This sub bands are checked by the psychoacoustic model, which defines masking thresholds. The sub-band samples are then quantized and encoded to keep the quantization noise below the masking threshold. The next step is to put all of these quantized samples together into frames so that the decoder can figure it out.

The frames are unpacked, sub-band samples are decoded, and a frequency-time mapping transforms them back into a single output audio signal, making decoding easier.

SBC systems have been created by many of the major audio firms and laboratories over the last five to ten years. Beginning in the late 1980s, the Motion Picture Experts Group (MPEG), an ISO standardisation body, produced basic rules for audio and video coding. Let's have a look at MPEG Audio as an example of a real-world SBC system.

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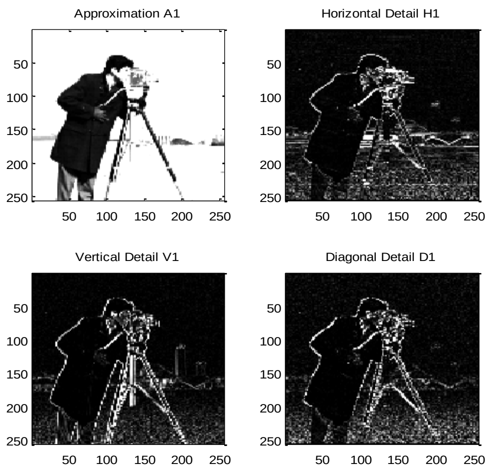
VIII. RESULTS AND DISCUSSION

In this section, we show the results and discussion of a suggested wavelet and subband coding approach for picture compression. For better results, we first use a grayscale image as an input. The grey scale image is then constructed up to two levels of reconstruction, compressed using wavelets, and then divided into sub-bands using these wavelets. Approximation, vertical, diagonal, and horizontal subbands of the image are produced before the output image is formed.Input image

Fig. 5. INPUT IMAGE



. Fig .6. 2D WAVELET

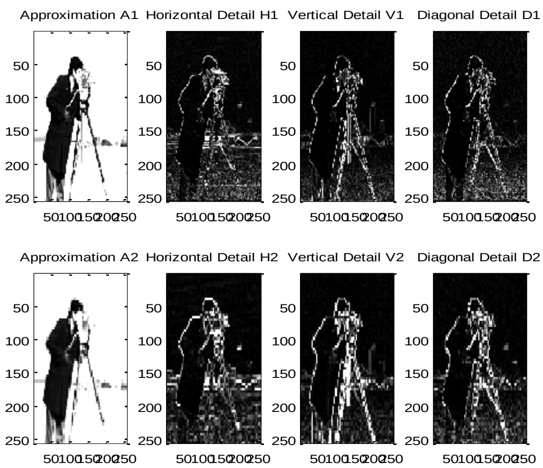


Fig. 7. 3D TRANSFORMATION

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Output image

Table.1 Comparison of Experiment Result

Wavelet based compression	PSNR
Experiment 1	50.8085
Experiment 2 (proposed)	65.4475

IX .CONCLUSION AND FUTURE WORKS

In general, the research's goals have been met. The most critical factor to consider, however, is image quality. This method can attain a level of accuracy of up to 98 percent. Although the algorithms provided in this project were created for a specific use, the theory behind them is very broad and can easily be applied to other applications. There's always potential for algorithm improvement, especially when it comes to using other face traits. This technology has a lot of potential because it can be used for a variety of things, including picture recognition and security. However, because most algorithms concern the matching process, this program's shortcoming is that it is extremely sensitive to image quality and size.Instead of using this project to create a static image, it would appear to be far more beneficial if it could be extended to a real-time application with no restrictions on image angle or backdrop images. As a result, several changes are required, particularly to save memory space. To reach a desired result, the same algorithms can still be used.

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