ABSTRACT: Image compression is very important for efficient transmission and storage of images. Images contain large amounts of information that requires much storage space, large transmission bandwidths and long transmission times. Therefore it is advantageous to compress the image by storing only the essential information needed to reconstruct the image. Image compression is a widely addressed researched area. Many compression standards are in place. But still here there is a scope for high compression with quality reconstruction. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) are the most commonly used transformation. DCT has high energy compaction property and requires less computational resources. On the other hand, DWT is multi resolution transformation. This research paper proposed a scheme for image compression using DCT and DWT named as hybrid compression technique. The purpose of this technique is to provide high compression rate by preserving the quality of reconstructed image. The algorithm performs the Discrete Cosine Transform (DCT) on the Discrete Wavelet Transform (DWT) coefficients. MATLAB was used to analyse the results of Image Compression and concluded that hybrid DWT-DCT algorithm performs much better than the standalone JPEG-based DCT, DWT algorithms in terms of peak signal to noise ratio (PSNR), as well as visual perception at higher compression ratio.

Keywords: Image compression, DCT, DWT, HYBRID (DCT+DWT), spatial Filtering.

I. INTRODUCTION:
Data compression is the technique to reduce the redundancies in data representation in order to decrease data storage requirements and hence communication costs. Data is represented as a combination of information and redundancy. Information is the portion of data that must be preserved permanently in its original form in order to correctly interpret the meaning or purpose of the data. Redundancy is that portion of data that can be removed when it is not needed or can be reinserted to interpret the data when needed. In order to lower the transmission and storage cost, image compression is desired. Most color images are recorded in RGB model, which is the most well known color model. However, RGB model is not suited for image processing purpose. For compression a luminance-chrominance representation is considered superior to the RGB representation. Therefore, RGB images are transformed to one of the luminance-chrominance models, performing the compression process, and then transform back to RGB model because displays are most often provided output image with direct RGB model.

There are two types of compression systems:-
Lossy compression System: - Lossy compression techniques can be used where some of the finer details of the image can be sacrificed for saving a little more bandwidth or storage space.
Lossless compression system: - Lossless compression system aims at retrieving the decompressed image identical to the original one.

![Image compression model](image.png)

Requirement for image compression system:
An image compression system requires the following two components:
- a. Encoding System (compression)
- b. Decoding System (decompression)

Data compression can be understood as a method that takes an input data and generates a shorter representation of the data with less number of bits.

II. NEED FOR COMPRESSION
To store these images, and make them available over network (e.g. the internet), compression techniques are needed. Image compression addresses the problem of reducing the amount of data required to represent a digital image. The underlying basis of the reduction process is the removal of redundant data. According to mathematical point of view, this amounts to transforming a two-dimensional pixel array into a statistically uncorrelated data set. The transformation is applied prior to storage or transmission of the image. At receiver, the compressed image is
decompressed to reconstruct the original image or an approximation to it. The example below clearly shows the importance of compression. An image, 1024 pixel×1024 pixel×24 bit, without compression, would require 3 MB of storage and 7 minutes for transmission, utilizing a high speed, 64 Kbits/s, ISDN line. If the image is compressed at a 10:1 compression ratio, the storage requirement is reduced to 300 KB and the transmission time drop to less than 6 second.

III. METHODOLOGIES USED FOR IMAGE COMPRESSION:

3.1 DISCRETE COSINE TRANSFORM:
A DCT represents the input data points in the form of a sum of cosine functions that are oscillating at different frequencies and magnitudes. There are mainly two types of DCT: one dimensional (1-D) DCT and two dimensional (2-D) DCT. Since an image is represented as a two dimensional matrix, for this research work, 2-D DCT is considered. The 2-D DCT for an input sequence can be defined as follows:

\[ D_{DCT}(i, j) = \frac{1}{\sqrt{2N}} B(i) B(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} X(x, y) \cos \left( \frac{(2x+1)}{2N} i \pi \right) \cos \left( \frac{(2y+1)}{2N} j \pi \right) \]

Where

\[ B(t) = \begin{cases} \frac{1}{\sqrt{2}} & \text{if } t = 0 \\ 1 & \text{if } t > 0 \end{cases} \]

For \( u = 0, 1, 2, \ldots N-1. \)

In the DCT compression, almost all of the information is concentrated in a small number of the low frequency coefficients. These low frequency coefficients are also known as DC components and the rest of the components are AC components. The DCT coefficients are then quantized using a quantization table, Q as described in the Joint Photographic Expert Group (JPEG) standard. The quantization is achieved by dividing each element of the transformed data by corresponding element in the quantization matrix Q and rounding to the nearest integer value as shown in Eq.

\[ D_{quant}(i, j) = \text{round} \left( \frac{D_{DCT}(i, j)}{Q(i, j)} \right) \]

Further compression is achieved by applying appropriate scaling factor.

The whole procedure is shown in Fig.

3.2 DISCRETE WAVELET TRANSFORM (DWT):
The DWT represents an image as a sum of wavelet functions, known as wavelets, with different location and scale. It represents the data into a set of high pass (detail) and low pass (approximate) coefficients. The input data is passed through set of low pass and high pass filters. The Daubechies filter coefficients are used for this work. The output of high pass and low pass filters are down sampled by 2. The output from low pass filter is an approximate coefficient and the output from the high pass filter is a detail coefficient. In case of 2-D DWT, the input data is passed through set of both low pass and high pass filter in two directions, both rows and columns. The outputs are then down sampled by 2 in each direction as in case of 1-D DWT. The complete process is illustrated in Figure. As shown in Figure, output is obtained in set of four coefficients LL, HL, LH and HH. The first alphabet represents the transform in row where as the second alphabet represents transform in column. The alphabet L means low pass signal and H means high pass signal. LH signal is a low pass signal in row and a high pass in column. Hence, LH signal contain horizontal elements. Similarly, HL and HH contains vertical and diagonal elements, respectively.

![Fig 3: Block diagram of the 2-level DWT scheme](image)

3.3 PROPOSED HYBRID DWT- DCT ALGORITHM USING SPATIAL FILTERING:

**SPATIAL FILTERING:**
Spatial filtering is a term used to describe the methods used to compute spatial density estimates for events observed at individual locations. Spatial prediction does not out-perform pure DCT based technique (such as JPEG) in terms of bit-rate tradeoff. However, at very low bit rates it results in far fewer blocky artifacts and markedly better visual quality. So for removing blocking artifacts near edges we need spatial filtering. Hybrid filtering method is used to combine both DCT and spatial filtering methods discussed already in previous section. There is no need of IDCT in hybrid filtering method. The hybrid method works by combining the filtering methods for three different grayscale gradient ranges respectively. It is used to get better processing speed, reduce blurring and enhance edges to a large extent. Therefore it can be used for high-speed noise elimination of 3D images with large data. We can implement this method by MATLAB.

**HYBRID DWT-DCT:** In the combined approach, both DCT and DWT are carried out on the image in some sequence one after the other in order to compress the image much more and achieve much higher compression ratios. Compression increases with increase in window size for DCT and
decreases with increase in window size for DWT. Here in this approach, first the image is divided into several blocks of images of size 32x32. Then 2D-DWT 1st level is applied on each block of image which results the image in four sub bands named LL, LH, HH, HL. Then on each sub band 2D-DWT 2nd level is applied again which again result in four different frequencies sub bands. Now first the scaling of these 8x8 blocks of images is done and done rescaling is performed via scaling factor.

![Fig 4: Hybrid Model](image)

IV. PROPOSED CONCEPT

Proposed concept is to follow for the hybrid concept of image compression technique. Coding redundancy, which is present when less than optimal code words are used. Inter pixel redundancy, which results from correlations between the pixels of an image. Spatial filtering is a term used to describe the methods used to compute spatial density estimates for events observed at individual locations. Spatial prediction does not out-perform pure DCT based technique (such as JPEG) in terms of bit-rate tradeoff. However, at very low bit rates it results in far fewer blocky artifacts and markedly better visual quality. It describes a set of tools for displaying functions estimated from these data points that are distributed in two-dimensional space. So when DCT is applied on DWT then it forms HYBRID DCTWT. Following steps are to be followed:

- The input image is first converted to gray image from colour image
- After this whole image is divided into size of 32x32 pixels blocks. Then 2D-DWT applied on each block of 32x32 block, by applying 2 D-DWT, four details are produced.
- Out of four sub band details, approximation detail is further transformed again by 2 D-DWT which gives another four sub-band of 16x16 blocks
- Above step is followed to decompose the 16x16 block of approximated detail to get new set of four sub band/details of size 8x8.
- Then on 8x8 block 2D-DCT is applied, and image is quantized and encoded.
- After we get (DWT+DCT) image, the non-zero pixel of DCT are filled in LL image pixel.
- Decomposition of image can be done for n-level as it removes the matching pixel.
- Finally spatial density is used to remove the noise and artifacts by using spatial filter.
- When the desired image is constructed through decompression, a process that uses the Inverse Discrete Cosine Transform (N-level-DCTWT).
- If n1=n2, then CR=1 and hence RD=0 which implies that original image do not contain any redundancy between the pixels.
- If n1>>n1, then CR→∞ and hence RD>1 which implies considerable amount of redundancy in the original image.
- If n1<<n2, then CR>0 and hence RD→∞ which indicates that the compressed image contains more data than original image.

The algorithm employs a two-dimensional (2-D) filter in the areas away from edges, and for near edges, one dimensional (1-D) filter aligned parallel to edge so as to reduce the blocking artifacts.

4. EVALUATION CRITERIA: In this section, the performance of the algorithms using two popular measures: compression ratio (CR) and peak signal to noise ratio (PSNR) has been analyzed. Mean Square error (MSE) Image having same PSNR value may have different perceptual quality.

PEAK SIGNAL-TO-NOISE RATIO (PSNR):

PSNR is usually expressed in terms of the logarithmic decibel scale. The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc.

\[
PSNR = 10 \cdot \log_{10} \left( \frac{\text{MAX}_{I}^2}{\text{MSE}} \right) = 20 \cdot \log_{10} \left( \frac{\text{MAX}_{I}}{\sqrt{\text{MSE}}} \right)
\]

COMPRESSION RATIO (CR): The compression ratio is defined as follows

\[
CR = \frac{\text{Discarded data}}{\text{Original data}}
\]

MEAN SQUARE ERROR (MSE): Mean square error is defined as the average of the square of the difference between the desired response and the actual system output.

\[
\text{MSE} = \frac{1}{MN} \sum_{x=1}^{M} \sum_{y=1}^{N} \left[ I(x,y) - \hat{I}(x,y) \right]^2
\]

Where \(I(x,y)\) is the original image, \(\hat{I}(x,y)\) is the approximated version and \(M,N\) are the dimensions of the images.

V. RESULT

In this section, we illustrate the effectiveness of the proposed hybrid coding scheme in comparison of DCT and DWT by means of the results obtained from the experimentation, proposed method was implemented in Matlab and the proposed hybrid coding scheme was evaluated using color images. Quality of the reconstructed images was determined by measuring the PSNR, MSE and the compression efficiency of the proposed hybrid scheme was determined in...
terms of the compression ratio, sample output obtained from
the proposed method as follows:

![Original image](image1)

![DCT Compress Image](image2)

![DCT Compress Image Corresponding YCbCr](image3)

**Fig 5: SIMULATION RESULT OF DCT:**

![Original image](image4)

![Compressed image](image5)

![Reconstructed image](image6)

**Fig 6: SIMULATION RESULT AFTER DWT:**

![Original Image](image7)

![Compression level decomposition](image8)

![Compression level decomposition](image9)

**Fig 7: SIMULATION RESULT AFTER HYBRID (DCT+DWT) USING SPATIAL FILTER:**

<table>
<thead>
<tr>
<th>COMPRESSION TECHNIQUE</th>
<th>C.R</th>
<th>PSNR</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCT</td>
<td>8.9</td>
<td>30.5</td>
<td>64.70</td>
</tr>
<tr>
<td>DWT</td>
<td>84.54</td>
<td>30.83</td>
<td>54</td>
</tr>
<tr>
<td>HYBRID DCT+DWT</td>
<td>96.63</td>
<td>45.15</td>
<td>2.53</td>
</tr>
</tbody>
</table>

**TABLE.1: Performance Comparison of DCT and DWT and PROPOSED HYBRID TECHNIQUE**

VI. CONCLUSION AND FUTURE SCOPE:

We concluded that both qualitatively and quantitatively the
DWT technique is better than the DCT filtering and SPATIAL filtering is better than the both. Because when we compare first two techniques that is DCT and DWT we observed that PSNR of second method is more than first and MSE and BER are less. And when we compare the three methods than we observed that hybrid (DCT+DWT+SPATIAL FILTER) is having good PSNR and lesser value of BER and MSE than the first two methods. As we know that for better filtering and recovering of images we need more PSNR and less BER and MSE so hybrid filtering is better than the both methods. The image compressed with hybrid technique will require less space for storage and less bandwidth while transmission over the network. This results in noticeable and annoying „blocking artifacts” particularly at low bit rates.

REFERENCES

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