Image Reconstruction Using Modified Hybrid Transform

By

Assist. Prof. Sulaiman Murtadha
Electrical Engineering Department
Baghdad University

Ali K.Ibrahee
Electrical Engineering Department
Baghdad University

ABSTRUCT:

In this paper, an algorithm for reconstruction of a completely lost blocks using Modified Hybrid Transform. The algorithms examined in this paper do not require a DC estimation method or interpolation. The reconstruction achieved using matrix manipulation based on Modified Hybrid transform. Also adopted in this paper smart matrix (Detection Matrix) to detect the missing blocks for the purpose of rebuilding it. We further asses the performance of the Modified Hybrid Transform in lost block reconstruction application. Also this paper discusses the effect of using multiwavelet and 3D Radon in lost block reconstruction.

Keywords: Modified Hybrid Transform, Lost Blocks, Detection Matrix

1. INTRODUCTION

The most important goal of any communication system is the sound and correct delivery of information between the source and the destination. General purpose images are most commonly compressed by lossy JPEG. JPEG divides the image into_blocks of 8× 8 pixels and calculates a two-dimensional (2-D)__discrete cosine transform (DCT), followed by quantization and_Huffman encoding, [1]. In common wireless scenarios, the image is transmitted over the wireless channel block by Block. Due to severe fading, we may lose an entire block, evenseveral consecutive blocks of an image. In [2] the authors report that average packet loss rate in a wireless environment is 3.6% and occurs in a bursty fashion. In the worst case, a whole line of image blocks might be lost. Note that JPEG uses differential encoding for storing the average (dc) value of successive pixels. Hence, even if a single block is lost, the remaining blocks in that line (or reset interval) might be received without their correct average (dc) value. Two common techniques to make the transmission robust are forward error correction (FEC) and automatic retransmission query protocols (ARQ). Of these, FEC needs extra error correction packets to be transmitted. ARQ lowers data transmission rates and can further increase the network congestion which initially induced the packet loss [3]. Instead, we show that it is possible to satisfactorily reconstruct the lost blocks by using the available information surrounding them. This will result in an increase in bandwidth efficiency of the transmission. The basic idea of this work is to detect the lost block and then fill it by the available surroundings by creating the (8×8×8) matrix from surrounding of the lost block and take the 3D transformation. The aim of reconstruction algorithms, is to heal wounded images that suffer from distortion as a result of losing information in some block locations, due to fading channels and traffic congestions and other transmission errors, which may cause this loss of information, and hence, emerging a reconstruction algorithm. The algorithm must manipulate such errors in order to ensure proper recovery to perform the reconstruction process effectively.

2. PREVIOUS RELATED WORK

Based on Walidlet transform, [4] proposed a new scheme for using walidlet transform of lost image blocks in wireless image transmission. This method employed a new approach of 2D-matrix manipulation. These methods of reconstruction consist of mainly generation of matrix manipulation, computation of the specified transformation and post processing to obtain the lost block. The manipulation matrix is of dimension (16 x 16), Formed from the 8 x 8 matrices that surround the lost block. Rane et al. [5], proposed a fast scheme for wavelet-domain interpolation of lost image blocks in wireless image transmission. The algorithm is designed to be compatible with the wavelet-based JPEG2000 image compression standard. In the transmission of block-coded images, fading in wireless channels and congestion in packet-switched networks can cause entire blocks to be lost. Instead of using common retransmission query protocols, lost blocks are reconstructed in the wavelet-domain using the correlation between the lost block and its neighbors. The algorithm first uses a simple method to determine the presence or absence of edges in the lost block. This is followed by an interpolation scheme, designed to minimize the block ness effect, while preserving the edges or texture in the interior of the block. The interpolation scheme minimizes the square of the error between the border coefficients of the lost block and those of its neighbors, at each transform scale. The performance of the algorithm on standard test images, its low computational overhead at the decoder. They [5] have also designed an algorithm for **Structure and Texture Filling-in of Missing Image Blocks in Wireless Transmission and Compression Applications. It was** an approach for filling-in blocks of missing data in wireless image transmission is presented in this paper. When compression algorithms such as JPEG are used as part of the wireless transmission process, images are first tiled into blocks of 8×8 pixels. When such images are transmitted over fading channels, the effects of noise can kill entire blocks of the image. Instead of using common retransmission query protocols, the algorithm aims to reconstruct the lost data using correlation between the lost block and its neighbors. If the lost block contained structure, it is reconstructed using an image inpainting algorithm, while texture synthesis is used for the textured blocks. The switch between the two schemes is done in a fully automatic fashion based on the surrounding available blocks. The performance of this method is tested for various images and combinations of lost blocks [6]. Waleed and Atheer[7],proposed a new scheme for Lost Block Reconstruction in noisey environment The reconstruction is achieved using the Boundary Interpolation (BI) which is based on wavelet transform. The algorithm's performance is further improved through the modification of the Boundary Interpolation algorithm.

3. The Modified Hybrid Transform.

The main idea behind the 3D-Modified Hybrid transform is first to apply the three dimensions discrete cosine Transform (3-D DCT) to the three dimensions signal (image). Next, to map the 3D object into 2D-object using the 3D Radon transforms. Hence, it is required to take the two dimension inverse Discrete cosine Transform (2-D IDCT) of the produced two dimensions signal. Finally, perform the 2D Multicircularlet transform of the resultant two dimensions signal. Thus the structure of this transform consists of four fundamentals parts,

Three dimensions Discrete Cosine Transform (3-D DCT).

Three dimension Radon Transform (3D-RT).

Two Dimension Inverse Discrete cosine Transform (2-D IDCT).

Two Dimension Multicircularlet Transform (2-D MCT) .

Fig.1 illustrates the block diagram of the 3D-Modified Hybrid Transforms.

It is expected that this Transform will give a high performance and strong properties. This is because it combines together the good properties of the local transforms.

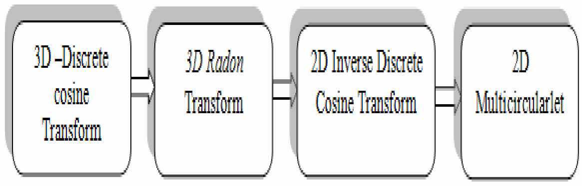

Fig. 1: block diagram of the 3D-Modified Hybrid Transforms

3.1 Algorithm for computing 3D Modified Hybrid Transform:

To compute 3D Modified Hybrid transform, the next steps should be followed:

i. Go to 3-D DCT:

Computing three dimensions discrete cosine Transform.

ii. Preprocessing: Here it is necessary to check for dimensions; matrix should be an N×N×N matrix, where N must be the prime number If the matrix is not of size N×N×N, a zero padding operation should be performed to the matrix (adding rows or columns or frames of Zeros to get a matrix of size N×N×N and they must be a prime number).

iii. Computing the best directions: To compute the best directions, the following steps should be followed:

Step1: Define (x, y, z) arbitrary vector.

Step2: Arrange vectors in volumes in different views X-view, Y-view, and Z-view

Step3: Calculate Φ and θ in Radian.

Step4: Convert X-view (Cart) to X-view (Spherical).

Step5: Convert Y-view (Cart) to Y-view (Spherical).

Step6: Round the X-view (Spherical) and Y-view (Spherical).

Step7: Rearrange the contain of data according to X-view (Spherical) and Y-view (Spherical).

iv. Compute the Fourier slices: Finding the Fourier slices

That must be taken. The resulting matrix after Fourier slices are (RR)

v. Back to the spatial domain:

Applying 2-D IDCT to resulting (RR) matrix.

vi. Resizing: resizing the resulting matrix into N×N where N must be of power 2

vii. **Applying 2D MCT:** Here it is apply the 2D dimensional discrete multicircularlet transform (2D MCT) [8].

3.2 The Inverse of the Proposed 3D – Modified Hybrid Transforms

In order to reconstruct the original 3-D signal (image) from the transformed matrix, an inverse 3D Modified Hybrid transforms steps must be followed. **Fig.2** illustrates the block diagram of the Inverse 3D-Modified Hybrid Transforms. The process starts by taking the Inverse Discrete Multicircularlet transform, using critically sampling scheme (1st order approximation of post processing). Then after preprocessing (resizing the resulting matrix) apply the two dimensional discrete cosine transform to the resulting matrix and then apply inverse 3D Radon transform and applying inverse 3D discrete cosine Transform and post processing. In the next sections a proposed algorithm to compute the inverse discrete multicircularlet transform using critical sampling preprocessing scheme.

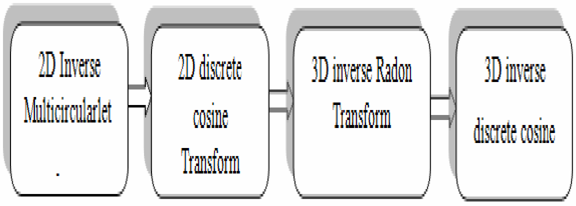

Fig.2 the Inverse 3D Modified Hybrid Transform

3.2.1 Algorithm for computing inverse 3D Modified Hybrid Transform

To reconstruct the original 3-D signal (N× N×N matrix) from the 3D Modified Hybrid transformed 3-D signal (N× N×N matrix), the Inverse 3D Modified Hybrid Transform should be used. The next steps exhibit the sequence of this algorithm:

1. Apply 2_D IMCT: Here it is required to apply the two dimension inverse discrete multicircularlet transform (2_DIMCT).

2. Inverse resizing: Check coefficients matrix length, length should be a prime number. If the coefficients matrix length is not a prime number, a zero padding operations should be performed to the coefficients matrix size, such as removing rows and columns from the coefficients matrix (which are added in the forward steps).

3. Apply 2-D DCT: Here it is required to apply the two dimensional discrete cosine transform.

4. Compute the best directions: The same geometrical algorithm of

Computing the best directions was applying in the forward steps and backward steps, described previously.

5. Compute the Fourier slices: Find the Fourier slices that must be taken.

6. Rearrang Fourier slices: Sort the Fourier slices according to the new positions, getting from compute the best sequence of directions is obtained.

7. Apply 3_D IDCT: Here it's required to apply 3D inverse discrete cosine transform.

4. The Main Structure of the Proposed Method Using 3D-Modified Hybrid Transform:

The reason for employing the 3D-Modified Hybrid transform instead of the 3D Radon or 3D- multiwavelet transforms is that, the 3D Modified Hybrid transform has the ability to detect sharp areas in images edges. This is an advantageous over other transforms that failed in reconstructing such areas, therefore it is predicted that this transform will have the capability to upgrade the reconstruction performance significantly.

In addition, the 3D Modified Hybrid owns many other characteristics that can be summarized in:

1- Maintaining the effect of two transforms at the same time, which are: the three dimension discrete cosine transform (3D DCT), and the 2D Multicircular let Transform (MCT).
2- Using the 3D Radon Transform helps visualizing the image with different angles.
3- Cartesian information is transformed into spherical information which is very important due to the difficulty of transforming images from spatial domain into spherical domain.
4- It is possible to employ the reconstruction process in different angles, that is because of the transformation of information from 3-D into 2-D implicitly.

According to the above, a study has been developed to use the 3D Modified Hybrid transform to reconstruct lost blocks in images. Initially, the idea was to implement the reconstruction within the 3D DCT, or 3D radon, or the 3D multiwavelet transforms.

The block diagram of the system can be concluded as depicted in **Fig.3**

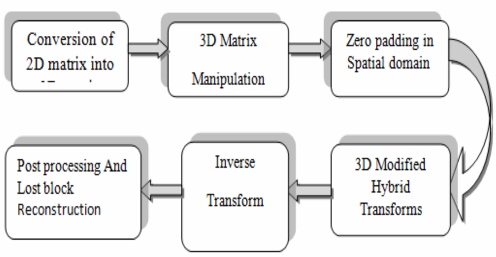

Fig.3 the proposed system using 3D Modified Hybrid Transform

It starts with zero padding in spatial domain and next 3D-matrix manipulation that is responsible of generating a (8×8×8) blocks matrix. This matrix (will be referred to as M matrix) will play the leading role in the reconstruction process.

The algorithm of the proposed system assumed a block of (8×8×3) is completely lost, and hence starts preprocessing to compute the Matrix from the lost block and the surrounding ones. The reason for selecting (8×8×3) size is the standardization that is followed in image compression. Knowing that it is impossible to transmit any image without compression due to its high size, hence the selection of (8×8×3) block size is beyond any dispute. The preprocessing start with zero padding in spatial domain and next 3D-matrix manipulation through which matrices of (8×8×3) that surrounds the lost block will be combined to create 3D matrix of size (8×8×8). Next, a transform computation will be applied which is either the 3D-Radon transform or the3D-multiwavelet transform. In this case a special method of computation was adapted for the application of the transformation. After arranging the (8×8×8) coefficient an inverse transformation will be followed. Finally the selection of the lost block will be according to a post processing depending on the manipulation followed before. The algorithm starts first by tiling the image into

8 x 8 blocks. Then iteratively, checking each block. If a lost block was detected, then start the Process of reconstruction according to the position of the lost block being Detection matrix method (DM), an easy to implement and efficient algorithm that can determine whether a block of an image has lost information or not. The next section will discuss in details of the detection matrix technique to give a comprehensive view of the reconstruction system proposed .

4.1 Detection Matrix for Lost Block Reconstruction

In order to perform the reconstruction process, a detection method should be enforced to find out the missing blocks. The proposed system presents a technique for lost block detection that is based on a specially generated matrix called the detection matrix. The idea is that, at any given block B of an image I, and after a quantization process Q (B) of presumed 16 levels. After several experimental tests it was found that for images of sizes 128 x 128 up to 512 x 512, the successful number of quantization levels was 16. The block B is said to be safe (no loss in its information) if each diagonal element in the detection matrix of the block B has a maximum value in its corresponding row. The main steps to compute the detection (DM) for a given image are illustrated in the following algorithm: The intensity image is quantized into 16 levels.

1) For the quantized image, the level **j** after level **i** is counted given that i = 1…16, j = 1…16.

3) The counted value is put in a new matrix called detection Matrix (DM) in the location (i, j).

4) For the final matrix, if the image does not have any lost blocks then for each row, the diagonal element has the maximum value in that row. Otherwise, the image has lost blocks [6].

5. Experiment results.

The following examples have been tested after setting the (M) matrix for each given transform to its best arrangement, to compare the performance of the proposed system with these transforms. The performance of the system using 3D Radon Transform illustrated in **Table 1**, the performance of the system using Multiwavelet transform illustrated in **Table 2**, finally the performance of the system using 3D Modified Hybrid Transform illustrated in **Table 3**.

Table.1 reconstruction example using Multiwavelet transform

images	Data lost	PSNR	MSE
1	3%	53.98db	0.0168
2	3.5%	50.74db	0.0157
3	3.66%	46.39db	0.0171
4	5%	42.56db	0.023
5	2.5%	55.389db	0.01801
6	7%	38.19db	0.0283
7	7.8%	38.106db	0.0289
8	11%	27.45db	0.0397
9	8.5%	31.625db	0.0429
10	4.7%	42.65db	0.0295

Table 2 reconstruction example using 3D-Radon transform

images	Data lost	PSNR	MSE
1	3%	56.98db	0.0162
2	3.5%	51.74db	0.0153
3	3.66%	48.39db	0.0168
4	5%	43.56db	0.021
5	2.5%	57.389db	0.0172
6	7%	39.19db	0.027
7	7.8%	39.106db	0.0281
8	11%	28.45db	0.0393
9	8.5%	33.625db	0.0421
10	4.7%	44.65db	0.0285

Table-3 reconstruction example using 3D-Hybrid transforms

images	Data lost	PSNR	MSE
1	3%	58.437db	0.0131
2	3.5%	52.331db	0.0149
3	3.66%	51.4db	0.0158
4	5%	44.82db	0.0196
5	2.5%	59.51db	0.0168
6	7%	41.744db	0.024
7	7.8%	40.19db	0.0267
8	11%	31.43db	0.037
9	8.5%	37.26db	0.0321
10	4.7%	48.359	0.0213

6. Conclusions

In this paper, a new algorithm of lost blocks reconstruction in RGB transmitted images is proposed. The originality of the proposed algorithm comes from the following features:

1- The algorithm is based on a matrix manipulation technique that is responsible for generating a (8×8×8) matrix in a block by block fashion. This generated matrix will be responsible of reconstructing the lost block after applying certain transforms. The use of the (8×8×8) generation matrix operations exhibit a better performance than the generation of (16×16) methods that suffer from many deficiencies of time consumption and accumulated errors.

2- The association of this matrix manipulation technique and its matching with those transforms that are dominated most researches in the field of image processing. Namely the 3D Radon, 3D-Multiwavelet, and the recently developed 3D-Modified Hybrid transform.

3- The system proposes a lost block detection scheme for identifying the lost information in an (8×8×3) image block fashion. This is done through the use of a proposed method for the generation of a special detection matrix.

4- The quality of reconstruction achieved when using the 3D Modified Hybrid transform, was remarkably higher than those associated with the 3D- multiwavelet and 3D Radon transform, especially in the cases of sharp edges.

Finally, although the performance of the reconstruction algorithm when using the 3D Modified hybrid transform is noticeably the best comparing with the 3D- multiwavelet and 3D Radon transforms, yet, generally the performance of the two transforms is highly acceptable. This is due to the involvement of the fast 3D-matrix manipulation technique incorporated in the three reconstruction algorithms.

7. References

[1] G. K.Wallace, “The JPEG still picture compression standard,” *Commun. ACM*, vol. 34, no. 4, pp. 30–44, 1991.

[2] E. Chang, “An image coding and reconstruction scheme for mobile computing,” in *Proc. 5th IDMS*, Oslo, Norway, Sept. 1998, pp. 137–148.

[3] S. S. Hemami, “Digital image coding for robust multimedia transmission,” in *Proc. Symp. Multimedia Communications and Video Coding*, New York, 1995.

[4] Sarwa Amir,” Lost Blocks Reconstruction in Image Transmission Systems Using the Walidlet Transform” PhD thesis, Iraqi Commission for Computers and Informatics Institute of Postgraduate Studies, June 2006.

[5]Shantanu D. Rane, J.R, and Guillermo**,** S., "Wavelet-Domain Reconstruction of Lost Blocks in Wireless Image Transmission and Packet-Switched Networks", IEEE **ICIP(1)** , pp. 309-312, 2002

[6]Shantanu D. Rane, J.R, and Guillermo**,** S., "Structure and texture filling-in of missing image blocks in wireless transmission and compression", IEEE ICIP, pp. 317-320, 2002.

[7] waleed A .mahmoud,Atheer A.sabri." **Wavelet & Multiwavelet Lost Block Reconstruction in Noisey Environment**"Eng.&Tech .journal,Vol 27,No.4,2009.

[8] Iman Alubady,"image compression using mixed transform",M.SC, thesis ,university of Baghdad,2009.