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Error Concealment of an Image by Hiding Data in Its Wavelet Coefficients

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Abstract— During transmission of images through a lousy transmission channel some packets are blocks get lost. To recover this many methods are proposed like forward error correction, retransmission, error concealment and error resilience. In image error concealment technique is recovering block at the receiver end using information in packets or blocks which are received without loss. In most of the method the information hidden inside the image before transmission is used for concealment. In the proposed method a error concealment method is developed which uses data hiding technique. A copy of the transmission image is hidden inside the transmission image in its wavelet coefficients before transmission. In order to achieve this image is resize converted to binary image each bit of binary image is stored in last bit of change in approximation wavelet coefficients of the same transmission image. It is observed that image after embedding the information in it originality is not affected. PSNR value between embedded image and original image is greater than any other embedding technique. At the receiver end image obtained with packet lost, lost packets are recovered from remaining packets. High boost median filter is applied iteratively to get the resultant image. The resultant image when compare to original image gives a higher PSNR value of 25 and above for a block loss of size 32x32 and below.

Keywords— Discrete Cosine transforms (DCT), Discrete Wavelet transform (DWT), image error concealment, Mean Square error (MSE), Peak signal to noise ratio (PSNR).

I. INTRODUCTION

Image is a two dimensional signal which resembles a physical object .image processing is a application of algorithm to process digital image to obtain enriched version of same image or to get the desired information from it. The application of image processing includes image polishing, restoration, in medical field, for remote sensing, Robotic vision, pattern recognition, television, and in hurdle detection. Image transmission is necessary; image transmission via a wireless channel requires the image to be compatible with the channel characteristics. Imperfect transmission of images which is coded in blocks result in block loss. While sending image in blocks (packets) through lousy transmission channel may leads to loss of blocks it may occur due to link failure. Many methods are proposed in order to overcome this packet loss. In most of the methods some information of the image to be transmitted is embedded in transmitted image itself which can be used to recover the lost information at the receiver side [1]. Error control mechanism includes error detection and correction. Examples of error control mechanism are Forward error correction, retransmission, error concealment, error resilience.

In error concealment lost packets (missing pixels) of the image are recovered using the information present in image using estimation and interpolation [2]. Forward error concealment is one of the error concealment technique in which some information is hidden inside the image before transmission, which can be used to recover the missing block at the receiver end. The hidden information can be kept in spatial domain or in frequency domain in most of the method [3]. Discrete cosine transmission is used in image compression. DCT divides image into sub bands of frequency domain. It represent image as a sum of sinusoids of various magnitude and frequencies used for lossy image compression. Discrete wavelet transform of image provides

spatial and frequency domain information of the image. DCT can be used to hide data in a redundant bit of the cover image. DWT can also be used to hide the secret image or data inside a cover image. In image error concealment technique using data hiding a copy of image is embedded inside the cover image which can be used to recover the missing block. In the proposed method embedding the information inside the image is done with the help of DWT.

Wavelet is the basic functions obtained after signal is decomposed using wavelet transform. Discrete time signal is converted to discrete wavelet signal using DWT. Wavelets are function for a finite intervals having average value is equal to zero. Wavelet is obtained from mother wavelet by dilation and shifting. DWT filtering can be done by successive low pass and high pass filtering of the discrete time signal. When wavelet transform is applied to image it will be converted into 4 sub bands CA, CH, CV, and CD where CA indicate low frequency sub band which indicate wavelet approximation coefficients of the input image. A copy of the image is hidden in CA coefficients of the transmitted image in the proposed method which is utilized for recovering packets at the receiver.

One method of image error concealment technique is using data hiding it is first introduced by Liu and Li [4]. Certain features are extracted from the image and these features are embedded in the original image through which concealment can be done. Lee and Won [5] introduced a technique in which watermarking sequence is generated using parities obtained through conventional error coding technique. Region of interest DCT bit stream is embedded into the region of coefficients of regional background [6].

Some of the other methods like inter frame or spatial EC technique [7]. This method can be used to get the missing pixels even after recovering image using hidden data in image because of missing of some of the hidden information. Different types of error concealment techniques are explained in surveys [8-10].

II. EXESISTING METHODS

some of the error concealment techniques which use data hiding method are given below.

Y.Wang , and Q-F, Zhu [11] proposed technique for error concealment for video images . At the transmitting and redundancy is added. This technique is also called as forward error concealment. It helps in resilience of bit streams. Error concealment is used at the decoder to recover the damaged areas using the characteristics of image and video signals.

P. Salama, N.B. Shroff [12] proposed technique in which lost pixel by recovered from the nearest undamaged pixels by spatial interpolation. The second approach by minimizing intersample variations across its boundaries and within each block lost micro blocks are recovered.

Y Liu and YLi [13] proposed technique in which the hidden data is extracted from the original image to be transmitted and this data is embedded back in to the same image the restored hidden data at the decoder is used to error concealment of lost data. J.W. Park and S.U. Lee [14] introduced a method in which NURBS (non uniform rational B-spline) function. Using optimization technique approximated surface of the neighboring image is generated. Edge linking algorithm is used for estimation of the edge components and edge components are enhanced using interpolation algorithm.

H Sun and W. Kwok [15] proposed a algorithm in which they mask the missing blocks by spatial and temporal interpolation to obtain a image which is approximately equal to original image. Guijin Tang, Xiuchang zhu [16] proposed a method in which correlation is performed to obtain disparity to match the blocks with the lost blocks and boundary smooth degreed (BSD) is calculated for each recovery block. If BSD exceeds the maximum threshold it indicate boundary is discontinuous using the BSD's of the neighboring blocks the content of the blocks is estimated adaptively by the different methods.

Jankoloda, Jugen seiler et.al [17] proposed a method for packet loss environment in which a block based coding scheme is used. The complexity of the algorithm depends on the visual complexity of the area which is recovered. Shuiming Ye Xinggang et. al [18] proposed a method in which the damage blocks are detected using the contextual information in the image like edge and consistency. Depending on the types of surrounding blocks missing blocks statistical characteristics are estimated .Different concealment methods are applied to different types of blocks (blocks with smoothness, edges, texture) .

lvana llieikova, Wanda Benesova et.al [19] proposed a method in which fuzzy segmentation is utilized to identify the logically associated region from the surrounding blocks to restore the corrupted region. Fuzzy segmentation allow to overlap segment and will include the soft edges also.Shabnam sodogari, Peyman Hesami [20] proposed a method in which linear predication residue and edge map of each block is embedded within the original image as a watermark before transmission. Using this watermark and by spatial smoothening the lost blocks are recovered.

Joost Rombout, Aleksondra [21] proposed a method in which lost blocks low frequency coefficients estimated by interpolation. The interpolation weights were optimally calculated from its neighborhood by using mean square error sense. It considers the error obtained during horizontal and vertical interpolation of the lost coefficients. Arash Baraumand , Alirera Nasiri et.al [22] proposed a method in which sequential best range matching (SBRM) algorithm is used. Lost packets or blocks of the image are obtained by the remaining or region of the image which is received by spatial similarities within the image. This method initializes denoising process and further estimation.

Neeraj Gadgil et.al [23] proposed a method in which multiple descriptions coding (MDC) is used. Decoder at the receiver has the capability of temporal and spatial error concealment by using MDC architecture with a four description.LY chen,S C chain et.al [24] proposed a method in which it combines adaptive markov random field (MRF) and motion in painting. Refining of result is employed by image in painting. At each point of the missing blocks effective compromise between spatial and temporal method is achieved. Han chaiang shyv, Jin jong [25] proposed a method uses genetic algorithm. error within the slice detected by checking a set of error detection condition during decoding and using block based back tracking procedure . for the corrupted blocks genetic algorithm is employed to conceal the corrupted blocks by cross over, mutation, reproduction iteratively. Stopping criteria is achieved by checking the required fitness fuction.

Yue shi, Xuhuizhu et.al [26] proposed a method in which error concealment is achieved by using new matching criteria for intra frames. Intra frames lost is recovered by this process.

Huajyan Luo ,Zong liang Gan [27] proposed a method which uses variation in neighboring pixels to classify a block into uniform block and edge block. Missing pixels are restored by nearest border prior spatial interpolation for uniform block and wiener interpolation algorithm for edge block.

Lijuan Song, Xiuchang Zhu [28] proposed a method to conceal compressed Stereoscopic image it uses two methods improved monocular EC mode or new binocular EC mode. The algorithm selects appropriate mode for concealment of the error block depending on the local characteristic of the error block.

Ismaeil, S Shirani [29] proposed a method similarity based error concealment (the missing block is replaced by the block connected to the layer which yields best match). The missing blocks of the image is first searched in lowest resolution then search on the full resolution. This algorithm follows diamond shaped search area. This method proposed a matching criteria which takes geometrical structure into account to extract the pixels of the lost block.

Neeraj Gadid et.al [30] proposed a method in which motion vector analysis is used. Temporal and spatial error concealment method used to improve the performance of multiple description coding (MDC). MDC is a efficient error resilient method used for application with multicast, scalable, P2P environment.

III. METHODOLOGY

In proposed method following steps to be followed in order to recover the packet lost using concealment technique. At the transmitting side steps followed are

1) Image is read as a matrix.
2) Color image matrix is divided into Red plane matrix, Green plane matrix and Blue plane matrix or (converted into gray image for demonstration) .
3) Convert indexed image into double image let the name of the image be I.
4) Apply two dimensional Discrete wavelet transform image will be converted into 4 matrixes named as CA,CV,CH,CD where CA indicate approximation coefficients, CV indicate vertical, CH indicate horizontal and CD indicate diagonal detail coefficients.

5) Choose CA coefficients, calculate size of this matrix let it be [m,n].

6) Reduce the image I to size (m,n) and then resize it to [m,n/8], let the new size of resultant image is (m1,n1).

7) Check each pixel value of the above resized image if it is less than zero or if it is greater than 255 or if it is not a number or infinity replace it by zero. Let this normalized image be J.

8) Convert each pixel of the J image into binary which result in each column of J which has integer values into 8 column of binary value. Thus the new size of the resulting binary image is (m,n). let the binary image is called as X2.

9) Each value of matrix CA is multiplied by 512 and then convert it to binary replace last bit by the value of the bit of binary image X2 then divide it by 512 to get new value of CA .

10) To the new CA matrix along with other coefficients of DWT (CV,CH,CD) inverse DWT is applied to get a image. This image is one which is transmitted and it has hidden copy of the same in its wavelet coefficients.

While transmission or receiving some blocks (packets) of the image may be lost, this can be demonstrated in this work by removing some of the blocks from the transmitted image which will be considered as received image I2.

At the receiver end following steps are used to get back the lost blocks

1) Apply DWT to the received image (I2) which gives CA, CH, CV, CD matrix.

2) Consider CA matrix; check each value in this matrix if it is less than zero make it equal to zero.

3) Multiply each value in CA matrix with 512 then convert it to binary. The last bit of the binary value is stored in matrix X3.

4) X3 is a binary image with size equal to CA (m,n). Resize X3 to size (mxn/8,8).

5) Convert each row of X3 matrix which has 8 columns of binary value to integer. Which result in a column matrix X4.

6) Resize X4 matrix into a matrix of size [m,n/8] . Once again resize it to size (m,n) let the obtained image be X5. Resize X5 image to the size of received image I2.

7) Filter the image X5 using median high boost filter. Now replace the missing blocks of received image (I2) with the corresponding blocks in X5 image.

8) Filter the new I2 image using iterative high boost median filter.

9) Compare the original image with the recovered image using PSNR and MSE for different size of blocks which are lost during transmission.

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they areused in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc,and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

IV. RESULTS AND DISCUSSION

Input image or image to be transmitted is as shown in figure 1. This is a gray image or red, green or blue plane of the color image.

Fig. 1. Input Image

For input image DWT is applied to get CA, CH, CV and CD wavelet coefficients these coefficients are displayed in figure 2. Data is hidden inside CA coefficients and then IDWT is applied to get back the image which has embedded information hidden in it as shown in figure 3.

Fig. 2. After applying DWT to input image

Fig. 3: Image with hidden information in its wavelet coefficients

The PSNR value between original image and embedded image is infinite and mse is zero means there is almost no change in values of original image and embedded image. Figure 4 shows image with lost blocks each block is of size 32X32 pixels. Figure 5 indicate image retrieved hidden image from the received image in which some blocks are lost. High boost median filtering is applied to this image to give image as shown in figure 6 and figure 7.Missing blocks of received image in figure 2 is filled by the corresponding blocks in image in figure7 the resultant image is as shown in figure 8.Some holes in figure 8 are filled by morphological filters and filtered once again to get final result as shown in figure 9. The PSNR and MSE values obtained for packet or block of different block size are as shown in Table 1. The Size of image is 768X1024 pixels.

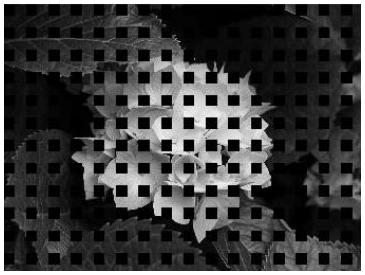

Fig. 4. Image with block's missing

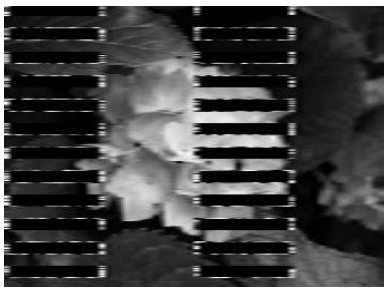

Fig 5: after removing hidden information from image.

Fig. 6. After applying High boost filtering

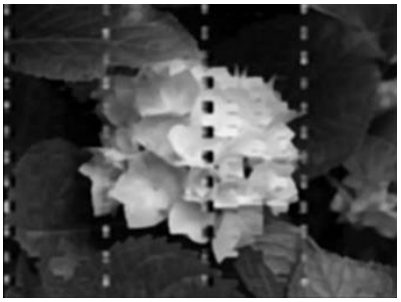

Fig.7. After applying iterative median filtering

Fig. 8.image obtained filling block lost in original received image using filtered hidden image using obtained from its wavelet coefficients

Fig. 9: image after filling holes in previous image.

TABLE I..PSNR And MSE Obtained Between Original Image And Recovered Image From Block Loss Of Different Size

BLOCK SIZE	PSNR	MSE
4X4	26.8135	0.53111
8X8	26.4631	0.575743
16X16	25.7301	0.681586
32X32	24.9572	0.814354
64x64	24.1287	0.985524
128X128	20.0037	2.547796
256X256	18.2878	3.782261
512X512	13.8511	10.50578
1024X1024	8.69774	34.41638

TABLE. 2. Compersion Of PSNR With Different Method And Our Proposed Method**.**

Image	Li'S	Salama's	Park's	Wang's	Sun's	Our'S
Baboon	**-**	**18.98**	**17.42**	**19.02**	**17.46**	**20.60**
tulips	**28.33**	**27.13**	**27.36**	**26.40**	**26.35**	**26.63**
Peppers	**27.25**	**23.69**	**24.48**	**24.06**	**22.19**	**24.12**
Lena	**26.46**	**23.99**	**26.96**	**24.41**	**23.93**	**24.17**

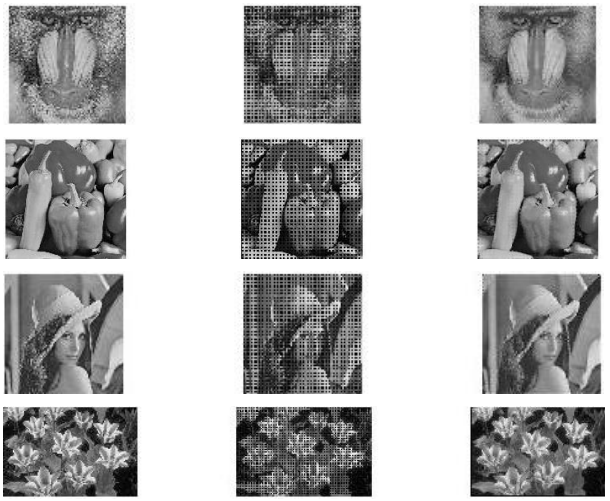

Fig. 10. Lena, pepper, tulips, baboon image with 8x8 block loss and recovered image using proposed method.

V. CONCLUSION

Image concealment technique using data hiding is used to recover the missing blocks of image which are lost during transmission in this work. Discrete wavelet transform (DWT) is applied to the image then a copy of the same image is resized and converted to binary. Binary image is hidden in one of the wavelet

coefficient and then Inverse DWT is applied to get image with embedded information in it. All of this procedure is done before transmission. At the Receiving end DWT is applied to a copy of received image using the value of the wavelet coefficient in which data is hidden binary image is extracted. This binary image is resized and filtered and can be used to recover the blocks lost. The result shows higher PSNR and low MSE to other technique in survey as well as gives consistent results for blocks of any size which are lost.

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