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A Multipurpose Image Processing Technique for Wireless and Wired Networks

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A Multipurpose Image Processing Technique for Wireless and Wired Networks

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Abstract **-** One of the most important and challenging goal of current and future communication network is transmission of high quality images from sender to receiver side quickly with least error where limitation of bandwidth is a prime problem.

Here we will discuss a new approach towards compressing and decompressing with perfect accuracy for its suitable transmission and reception. This technology is also helpful in Server and Client models used in industries where a large number of clients work over a single Server. Hence to minimize the load during transmission of a volumetric image/video this process can be implemented.

Keywords - *MRT based Compression & Decompression, Communication algorithm, Single window concept, Applications.*

I. INTRODUCTION

Data compression is important in storage and transmission of information. Especially digital image compression is important due to the high storage and transmission requirements. Various compression techniques have been proposed in recent years to achieve good compression. Here we'll discuss about a new Image compression technique, based on MRT [6].

A picture may be worth thousand words, but it requires far more memory, bandwidth and transmission time. The present technology demands the transmission of images with small size, reduced bandwidth and high speed. So we need to compress the image with maximum compression ratio and the best quality. Transform coding using the 2-D block discrete cosine transform (DCT) is a proven method for image compression and widely used by both the academic and industrial image processing communities. In transform coders, the image to be compressed, is subject to an invertible transform with the aim of converting the statistically dependent image coefficients to independent coefficients by redundancy reduction. Further compression is achieved through irrelevancy reduction . Data that are considered irrelevant and do not convey significant information about the image are discarded. The computation time is an important factor in choosing image compression / decompression technique which in turn depends on the selection of transform. In this work redundancy reduction is achieved through the transform named MRT, which involves only real addition and irrelevancy reduction by applying threshold.

II. MRT

Let the elements of a data matrix be $X_{n_1 n_2}$, $\leq n_1$,$n_2 \leq N-1$ and the MRT coefficients be

$y_{k_1,k_2}^{(p)}$ $0 \leq k_1$, $k_2 \leq N-1$ and $0 \leq p \leq M-1$, $M=N/2$

Where

$$y_{k_1,k_2}^{(p)} = \sum_{n_1,n_2|z=p} X_{n_1 n_2} - \sum_{n_1,n_2|z=p+M} X_{n_1 n_2}$$

$$Z = ((n_1 k_1 + n_2 k_2))_N$$

Above maps the NxN data matrix into M matrices of size NxN in the frequency domain using real additions only. The inverse transform relation is as follows

$$X_{n_1 n_2} = \frac{1}{N^2} \sum_{q=o}^{1} X_{n_1,n_2}^{(q)},\ 0 \leq n_1, n_2 \leq n_1 N-1$$

Where

$$X_{n_1,n_2}^{(q)} = \sum_{(k_1,k_2),p|j=q} Y_{k_1,k_2}^{(p)} - \sum_{(k_1,k_2),p|j=q+M} Y_{k_1,k_2}^{(q)}$$

$$J = ((((-((n_1 k_1 + n_2 k_2))_N))_N + p))_N$$

On analysis of the MRT matrices it is found that a majority of its coefficients are redundant. The MRT of an 8x8 data block will have 256 MRT coefficients of which only 64 are unique and have fixed position. Thus only 64 unique coefficients are required for reconstruction of the original data. This property of

MRT is exploited in image compression. Both MRT and MRT based Image compression are evolving subjects.

MRT Based Image Compression:

The MRT based Image compression utilizes the 64 unique MRT coefficients to represent each 8x8 block of the image for encoding. Certain coefficients among the unique coefficients are irrelevant for reproducing the original image block with some acceptable error [10]. This irrelevancy is removed by applying threshold to the unique coefficients. The value of the threshold can be chosen with a compromise between compression and quality. The coefficients that overcome the threshold in each block and their corresponding positions in the MRT matrices are stored in separate linear arrays and encoded using arithmetic coding. The steps involved in the compression technique are shown in figure 1.

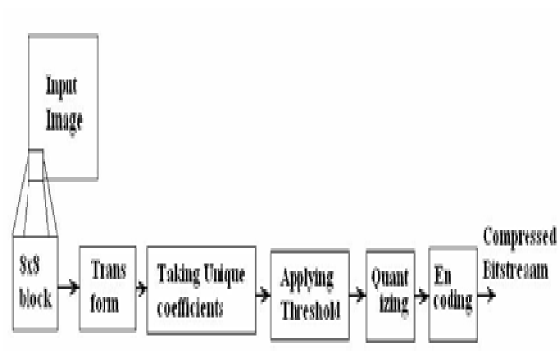


Fig. 1 : Block diagram of a standard transform coder

In the decompression process, both position vector and coefficient vector are decoded using arithmetic decoding. The MRT matrices are formed for each block by placing the unique coefficients from the coefficient vector with reference to the positions in the position vector. The inverse MRT is applied and the output image block is placed in the corresponding position. This process is repeated for all the blocks.

Simulation Results:

The simulation is performed for different types of images with fixed threshold, table 1, and on lenna image with variable threshold, table 2 and figures 3 to 6, to analyse their effect on bits per pixel (bpp), peak signal to noise ratio (PSNR) and percentage compression.

Figure 2(a) shows the original lenna image and figure 2(b) its reconstructed image with bpp 1.07 and PSNR 27.88. The table 1 and figure 2 shows that the MRT based compression technique gives good quality image with very high percentage compression for variety of images.

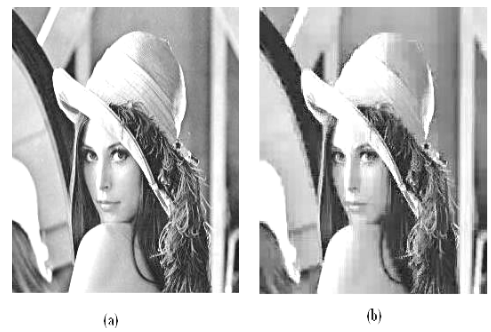


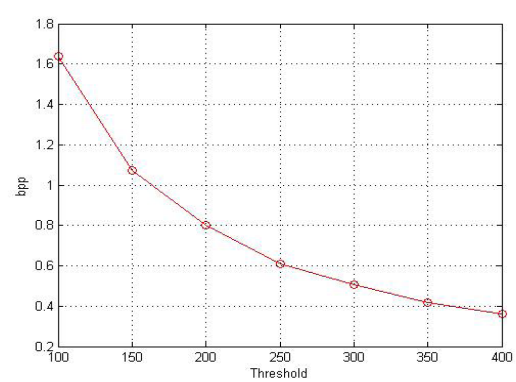
Fig. 2 : Lenna (a) original and (b) reconstructe

Image	Threshold	bpp	PSNR	% Compression
Lenna	150	1.07	27.88	86.60
Cameraman	150	0.91	28.91	88.57

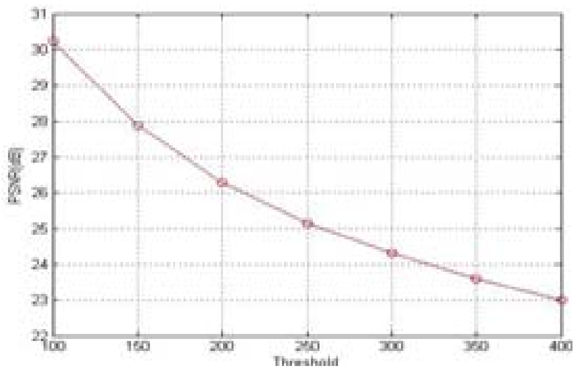
Table 1

Threshold	% compression	bpp	PSNR(dB)
100	79.54	1.64	30.22
150	86.60	1.07	27.88
200	89.97	0.80	26.29
250	92.39	0.61	25.14
300	93.65	0.51	24.31
350	94.77	0.42	23.59
400	95.48	0.36	22.98

Table 2



Graph 1 bpp versus Threshold



Graph 2 PSNR(dB) versus Threshold

Above Table and figures shows that bpp, PSNR and percentage compression are dependent on threshold, which can be chosen depending on whether quality or compression is important. As threshold increases PSNR & bpp decreases and compression increases.

A comparison between DCT and MRT based image compression techniques is presented in table 3. The DCT based image compression is implemented as in [9]. The table illustrates that the MRT based image compression technique gives better compression with better PSNR for nearly equal or less bpp over traditional DCT based approach. MRT based approach has the advantage over that of DCT in compromising between quality and percentage compression by varying threshold.

Image	Threshold	bpp		% comp.		PSNR (dB)	
		DCT	MRT	DCT	MRT	DCT	MRT
Lenna	195	0.84	0.82	89.45	89.74	27.81	26.40
Cameraman	200	0.73	0.70	90.87	91.22	26.61	27.34

Table 3

Communication process:

Once compression process is over means our data is ready for transmission over the channel. Recent advances in scalable image compression have made it possible to decode images in a progressive fashion. Emerging standards like JPEG2000 are being built around scalable coders. Transmission of images over wireless channels suffers from drawbacks like bit error due to bit errors caused by channel fading and noise. Error control solutions have been purposed which seek to address this problem. But most are sensitive to location of errors or require large interleaves to spread errors out[1]. Hence here we'll utilize product code framework for transmitting images over the wireless fading channel.(using forward error correction codes)

This product code approach is ideally suited to the emerging heterogeneous networks scenario, where the data can encounter packet losses caused by congestion at routers as well as bit errors on the wireless link.

To achieve the joint optimization of source and channel coding, two optimizers are implemented for Reed Solomon row codes: a provably-optimal optimizer using dynamic programming and a fast, nearly-optimal Lagrange optimizer[2]. By coding the embedded source bit stream with an erasure-correction code, we form multiple descriptions against bit errors occurring in the fading channel. Using the nearly-optimal Lagrange optimizer for the Reed-Solomon row codes along with the RCPC+CRC column codes,, we create an efficient, practical image transfer system which gives results that are better than normal techniques. The codes also render all transmitted packets equally important, resulting in a coding scheme that is insensitive to which packets are actually received. This matches well with network that have no means of prioritizing packets, including today's internet.

III. A MULTIPLE-DESCRIPTION PRODUCT CODE

Rather than using conventional interleaves, we use a multiple-description approach to protecting images sent over a wireless fading channel. In this section, we'll go into the depth of product code. All multiple-description codes approach the problem of splitting a source image into several descriptions. These descriptions are created so that when more descriptions are used to decode the image the decoded image quality increases. Although the creation of these descriptions can be done by the source coder[3], this approach tends to be somewhat inflexible and is often limited to creating a small number of image descriptions. Therefore, rather than taking a source-coder based approach to the creation of multiple-description codes, we instead use Reed-Solomon erasure-correction codes to recreate the information contained in lost packets. If Reed-Solomon codes are allocated across blocks so that each Reed-Solomon block contains exactly one symbol in each packet, which packets arrive at the receiver is irrelevant; the block's data can be recovered if the number of packets that arrived is greater than or equal the number of data symbols in that packet. Starting with a progressive bitstream, we can easily create multiple, equally important descriptions of the source image using these Reed- Solomon by decreasing the number of parity symbols included in the reed-Solomon block as the source bits encoded in that block become less important[4]. We'll generate the bit stream by using the popular SPIHT[5] image coder. The bit stream is then passed to the MD-FEC transcoder, which chooses the unequal protection Reed- Solomon codes based on the source image rate-distortion curve and channel state. Once the code structure is determined, the data is split into packets and the Reed-Solomon forward error correction is added. Each packet is then encoded using a convolution code to protect it from the scattered bit errors introduced by the wireless channel. The system block diagram is shown figure 1

Mechanism of Transmission and reception

Although the distinction is artificial, for our packetization scheme it is convenient to think of the RCPC+CRC codes as being "channel" codes and the Reed-Solomon codes as being part of the " source" code.

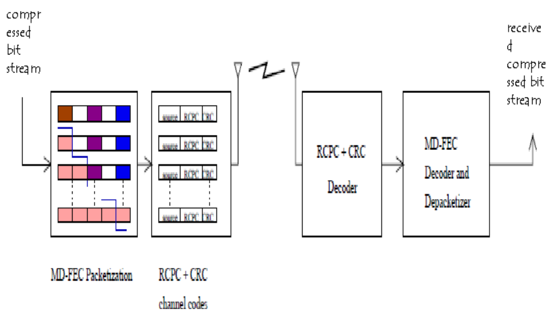


Fig. 1 : Block diagram for transmission and reception

The RCPC codes allows reasonable confidence that the transmitted descriptions will be received correctly except during deep fades; the added CRC codes allow the channel to be treated as an erasure channel by preventing erroneous data from being decoded and processed.

Distinguishing between the RCPC+CRC "channel" codes and the Reed-Solomon "source" codes allows us to analyze the transmission of the embedded image over a wireless channel without considering individual bit errors. Since the CRC codes essentially prevent any bit errors introduced by the channel from being seen by the "source" codes, we can assume that there are no bit errors in the channel. We can then view the wireless channel and the RCPC+CRC[11] codes as a system for transmitting multiple descriptions of an image with some probability of successfully delivering different subsets of those descriptions.

Now we are almost clear that the key to this scheme is a method for allocating protection levels to Reed-Solomon columns so as to minimize an objective measure of image distortion. Here we considered optimizing the bit stream to minimize the expected mean square error at the receiver.

By using the process as shown in figure 1 we are now having the compressed bit stream which is now ready for transmission over the channel. Here we are utilizing the same MD-FEC transcoder for packetization of the obtained bit stream and next again one CRC is used to minimize the error rate as much as possible. Now it is ready to transmit over the wired or wireless network according to its use.

Again on the reception side same methodology is used to prepare the compressed bit stream which is again decompressed using the same MRT based scheme as explained above.

IV. COMPLETE PROCESS

The complete process of image transformation can be visualized in the next figure.

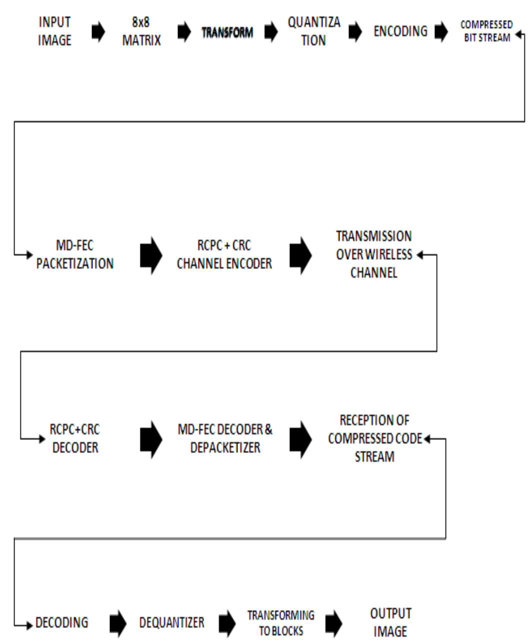


Fig. 2

Application

As this algorithm is very easy to implement it can be converted into small packages which can be utilized in a number of areas like web applications, mobile services for multimedia applications also in intranet Wi-Fi services. Also the same algorithm can be implemented using J2EE and J2ME for both embedded and web applications.

For understanding purpose let's consider the above algorithm is implemented using J2ME hence now this code can be converted into byte code by JVM and finally fused into the a chip i.e. used in a wireless enabled device hence whenever the user will try to transmit any image it will process through the above process which will decrease the size of the image hence less BW will be used so automatically speed will get enhanced. But the limitation is the receiver must be synchronized to the same algorithm otherwise it will show error.

Result

From table 3 we can see that in all features like compression ratio, PSNR MRT scheme is better and once the image is compressed it's easy to decompress because the same approach is used for it only in a reverse way. Next is the channel over which it is going to be transmitted. Here we have considered a standard technique for this processing which gives the result more accurately.

We have applied the complete process on a simple FTP server used in a P2P connection and found that the accuracy is around 97.67% which is best in its arena.

STEPS

Step-1: Image was compressed using MRT SCHEME.

Step-2: Now ftp server was opened and the compressed image was transmitted via proper command.

Step-3: The compressed image was received in receiver side and inverse MRT was applied to obtain the original.

Step-4: It was compared with original image by counting the no pixels and BPP in the image and error percentage was calculated.

V. CONCLUSION

This approach to image transmission over a wireless fading channel proves to be highly effective offering a significant improvement over the current state of the art. By efficient adaptive coding to match channel parameters, this scheme simultaneously lower both the mean and the best case distortion at the receiver.

As this process was successful in FTP server it can be further implemented other types of web servers in both wired and wireless channels.

REFERENCES

[1] P.G Sherwood and k.Zeger, ‘’Error Protection for Progressive Image Transmission Over Memoryless and Fading Channels.” ICIP, Chicago, Illinois, October 1998.

[2] R puri and K ramachandran, “Multiple description coding using forward error correction codes”proc. Of 33rd Asilomar Conference on Signals and Systems Pacific Grove, CA, Oct, 2000.

[3] V.A. Vaishampayan, “Design of multiple description scalar quantizers,” IEEE Transaction on Information Theory., 39(3)821 834, May 1993.

[4] G.Davis, J.Danskin, “Joint Source and Channel Coding for Image Transmission over Lossy Networks”, proceeding of the SPIE,Denver, CO,USA,August 1996,pp. 376-387.

[5] A.Said and W.A.Perlman. “A new fast and efficient image codec based on set partitioning in hierarchical trees”IEEE Trans on CSVT 243:250 1996

[6] Rajesh Cherian Roy, and R. Gopikakumari “A new transform for 2-D signal representation (MRT) and some of its properties”, 2004 IEEE International Conference on Signal Processing & Communications (SPCOM), pp. 363- 367 Dec. 2004, Bangalore, India.

[7] “CCITT SG XV working party XV/4, Specialist group on coding of visual telephony, Description of reference model 8 (RM8),” Doc. 525, June 1989.

[8] K. Rose, A. Heinman, and I. Dinstein, “DCT/DST alternate transform image coding,” IEEE Trans. Commun., vol. 38, pp. 94-101, Jan. 1990.

[9] R. C Gonzales and R. E Woods, “Digital Image Processing” Reading, MA: Addison-Wesley, 1992.

[10] H. Musmann, P.Pirsch, and H. Grallert, “Advances in picture coding” , proc, IEEE, pp. 523-542, Apr. 1982

[11] Giuseppe baruffa, paolo micanti, student member, ieee, and fabrizio frescura”Error protection and interleaving for wireless transmission of jpeg 2000 images and video” IEEE transactions on image processing, vol. 18, no. 2, february 2009

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