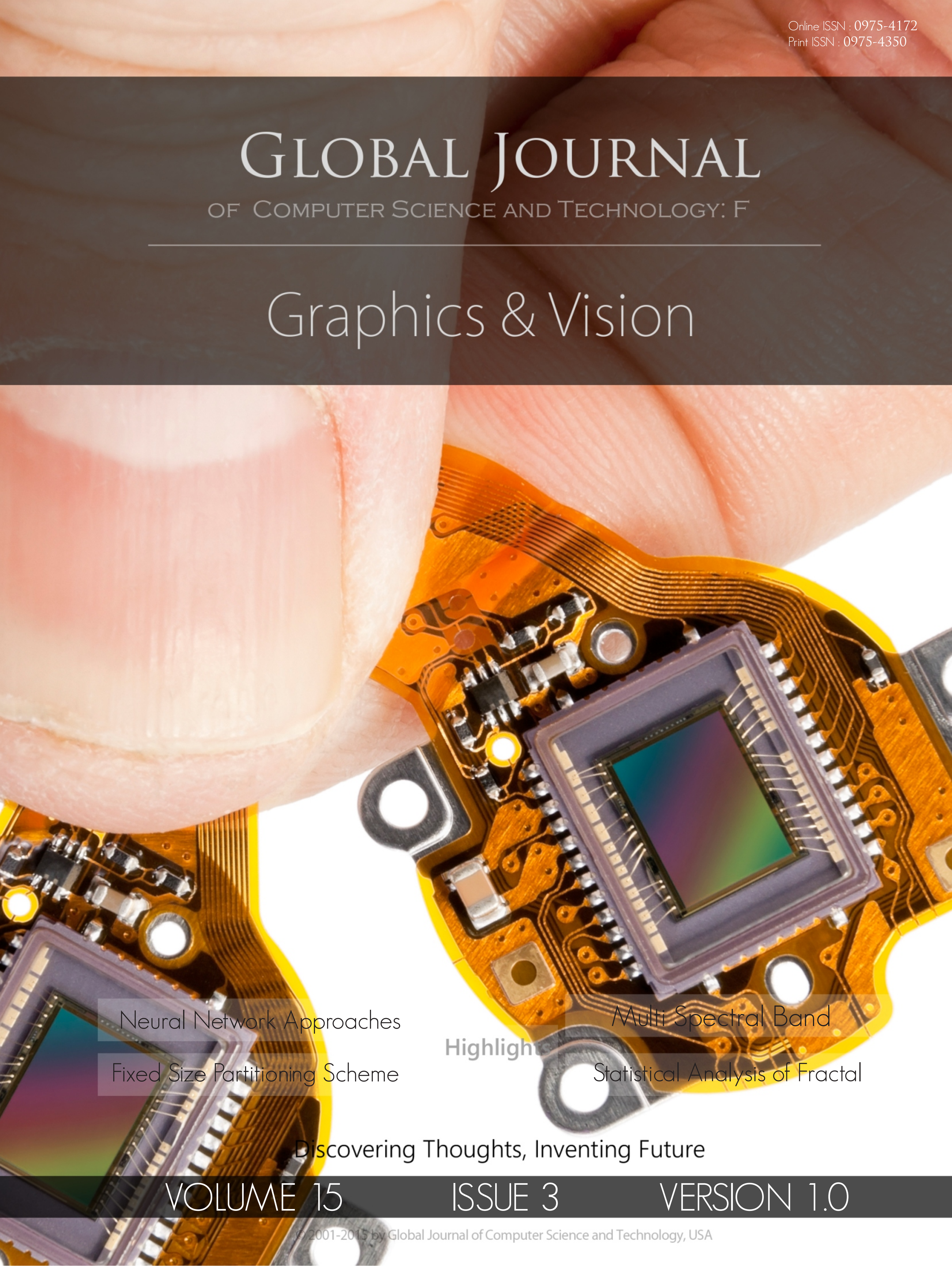

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Discrimination of Textures using Texton Patterns

By Shaik Rahamat Basha & P Kiran Kumar Reddy

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Abstract- Textural patterns can often be used to recognize familiar objects in an image or retrieve images with similar texture from a database. Texture patterns can provide significant and abundance of texture and shape information. One of the recent significant and important texture features called Texton represents the various patterns of image which is useful in texture analysis. The present paper is an extension of our previous paper [1]. The present paper divides the 3 $\times$ 3 neighbourhood into two different 2 $\times$ 2 neighbourhood grids each consist four pixels. On this 2 $\times$ 2 grids shape descriptor indexes (SDI) are evaluated separately and added to form a Total Shape Descriptor Index Image (TSDI). By deriving textons on TSDI image Total Texton Shape Matrix (TTSM) image is formed and Grey Level Co-Occurence Matrix (GLCM) parameters are derived on it for efficient texture discrimination. The experimental result shows the efficacy of the present method.

Keyward: textons, glcm features, shape descriptor index (sdi), total shape descriptor index image (tsdi). total texton shape matrix (ttsm), 2 $\times$ 2 grids.

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DISCRIMINATIONOFTEXTURESUSINGTEXTONPATTERNS

Strictly as per the compliance and regulations of:

Discrimination of Textures using Texton Patterns

Shaik Rahamat Basha [α] & P Kiran Kumar Reddy [σ]

Abstract- Textural patterns can often be used to recognize familiar objects in an image or retrieve images with similar texture from a database. Texture patterns can provide significant and abundance of texture and shape information. One of the recent significant and important texture features called Texton represents the various patterns of image which is useful in texture analysis. The present paper is an extension of our previous paper [1]. The present paper divides the 3 × 3 neighbourhood into two different 2 × 2 neighbourhood grids each consist four pixels. On this 2 × 2 grids shape descriptor indexes (SDI) are evaluated separately and added to form a Total Shape Descriptor Index Image (TSDI). By deriving textons on TSDI image Total Texton Shape Matrix (TTSM) image is formed and Grey Level Co-Occurence Matrix (GLCM) parameters are derived on it for efficient texture discrimination. The experimental result shows the efficacy of the present method.

Keywords: textons, glcm features, shape descriptor index (sdi), total shape descriptor index image (tsdi). total texton shape matrix (ttsm), 2 × 2 grids.

I. Introduction

Analysis of texture requires the identification of proper attributes or features that differentiate the textures in the image for segmentation, classification and recognition. Initially, texture analysis was based on the first order or second order statistics of textures [6, 7, 8, 9, 10]. Then, Gaussian Markov random field (GMRF) and Gibbs random field models were proposed to characterize textures [11, 12, 13, 14, 15, 16]. Later, local linear transformations are used to compute texture features [17, 18]. Then, texture spectrum technique was proposed for texture analysis [19]. The above traditional statistical approaches to texture analysis, such as co- occurrence matrices, second order statistics, GMRF, local linear transforms and texture spectrum are restricted to the analysis of spatial interactions over relatively small neighborhoods on a single scale. As a consequence, their performance is best for the analysis of micro textures only [20]. More recently, methods based on multi-resolution or multi-channel analysis, such as Gabor filters and wavelet transform, have received a lot of attention [21, 22, 23, 24, 25, 26, 27, 23, 25]. From the literature survey, the present study found the Gray Level Co-occurrence Matrix (GLCM) is a benchmark method for extracting Haralick features (angular second moment, contrast, correlation, variance, inverse difference moment, sum average, sum variance, sum entropy, entropy, difference variance, difference entropy, information measures of correlation and maximal correlation coefficient) or Conners features [28] (inertia, cluster shade, cluster prominence, local homogeneity, energy and entropy). These features have been widely used in the analysis, classification and interpretation of remotely sensed data. Its aim is to characterize the stochastic properties of the spatial distribution of grey levels in an image.

The present paper is organized as follows. In he second section we have given clear information about grey level co-occurrence matrix information and the third section we discussed about textons. In fourth section we discussed deriving different Shape Descriptor Indexes (SDI). In the fifth section, proposed methodology is discussed and in sixth section results and discussions are given. Finally in last section we concluded about this paper.

II. Gray Level Co-occurrence Matrix

One of the other most popular statistical methods used to measure the textural information of images is the Gray Level Co-occurrence Matrix (GLCM). The GLCM method gives reasonable texture information of an image that can be obtained only from two pixels. Grey level co-occurrence matrices introduced by Haralick [29] attempt to describe texture by statistically sampling how certain grey levels occur in relation to other grey levels. Suppose an image to be analyzed is rectangular and has N_x rows and N_y columns. Assume that the gray level appearing at each pixel is quantized to Ng levels. Let $L_x = \{1,2,\ldots,N_x\}$ be the horizontal spatial domain, $L_y = \{1,2,\ldots,N_y\}$ be the vertical spatial domain, and $G = \{0,1,2,\ldots,N_g-1\}$ be the set of Ng quantized gray levels. The set $L_x \times L_y$ is the set of pixels of the image ordered by their row-column designations. Then the image I can be represented as a function of co-occurrence matrix that assigns some gray level in $L_x \times L_y$; $I: L_x \times L_y \rightarrow G$. The gray level transitions are calculated based on the parameters, displacement (d) and angular orientation (θ). By using a d istance of one pixel and angles quantized to 45^0 intervals, four matrices of horizontal, first diagonal, vertical, and second diagonal (0^0, 45^0, 90^0 and 135^0 degrees) are used. Then

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the un-normalized frequency in the four principal directions is defined by Equation (1).

$$p(i,j,d,\theta)=\#\left\{\begin{array}{l}((k,l),(m,n)\in \mid (L_x\times L_Y)\times(L_x\times L_Y)\mid \\ (k-m=0,\ |l-n|=d)\text{ or }(k-m=d,\ l-n=-d) \\ \text{or }(k-m=-d,\ l-n=d)\text{ or }(|k-m|=d,\ l-n=0) \\ \text{or }(k-m=d,\ l-n=d)\text{ or }(|k-m|=-d,\ l-n=-d) \\ I(k,l)=i,\ I(m,n)=j\end{array}\right. \qquad (1)$$

where # is the number of elements in the set, (k, l) the coordinates with gray level i, (m, n) the coordinates with gray level j. The following Fig. 1 illustrates the above definitions of a co-occurrence matrix (d=1, $\theta = 0^0$).

(a)

3	3	3
1	3	3
1	3	2

(b)

0^0	1	2	3
1	0	0	2
2	0	0	0
3	0	1	3

(c)

45^0	1	2	3
1	0	0	2
2	0	0	0
3	0	0	2

(d)

90^0	1	2	3
1	1	0	1
2	0	0	1
3	0	0	3

(e)

135^0	1	2	3
1	0	0	0
2	0	0	1
3	0	0	2

Figure 1: An example of Gray level co-occurrence matrix

Even though Haralick extracted 24 parameters from co-occurrence matrix, the present paper used only energy, contrast, local homogeneity, and correlation as given in Equations (2) to (5).

$$\text{Energy} = \sum_{i,j=0}^{N-1} -\ln\left(P_{ij}\right)^2 \qquad (2)$$

Energy measures the number of repeated pairs and also measures uniformity of the normalized matrix.

$$\text{Contrast} = \sum_{i,j=0}^{N-1} -P_{ij}\,(\mathrm{i}-\mathrm{j})^2 \qquad (3)$$

The contrast feature is a difference moment of the P matrix and is a standard measurement of the amount of local variations present in an image. The higher the value of contrast are, the sharper the structural variations in the image.

$$\text{Local Homogenity} = \sum_{i,j=0}^{N-1}\left(\frac{P_{ij}}{1+(\mathrm{i}-\mathrm{j})^2}\right) \qquad (4)$$

It measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. The converse of homogeneity results in the statement of contrast.

$$\text{Correlation} = \sum_{i,j=0}^{N-1}\left(P_{ij}\,\frac{(\mathrm{i}-\mu)(\mathrm{j}-\mu)}{(\sigma)^2}\right) \qquad (5)$$

Where P_{ij} is the pixel value in position (i, j) of the texture image, N is the number of gray levels in the image, μ is $\mu = \sum_{\mathrm{i,j}=0}^{\mathrm{N}-1} \mathrm{i}P_{ij}$ mean of the texture image and $(\sigma)^2$ is $(\sigma)^2 = \sum_{i,j=0}^{N-1} P_{ij}\,(\mathrm{i}-\mu)^2$ variance of the texture image. Correlation is the measure of similarity between two images in comparison. The measures mean (m), which represents the average intensity.

III. Textons

Textons [30, 31] are considered as texture primitives, which are located with certain placement rules. A close relationship can be obtained with image features such as shape, pattern, local distribution orientation, spatial distribution, etc. using textons. The textons are defined as a set of blobs or emergent patterns sharing a common property all over the image. The different textons may form various image features. To have a precise and accurate texture classification, the present study strongly believes that one need to consider all different textons. That is the reason the present study considered all. There are several issues related with i) texton size ii) tonal difference between the size of neighbouring pixels iii) texton categories iv) expansion of textons in one orientation v) elongated elements of textons. By this sometimes a fine or coarse or an obvious shape may results or a pre-attentive discrimination is reduced or texton gradients at the texture boundaries may be increased. The present paper utilized the following five texton shades of 2×2 grid shown in Fig. 2. In Fig. 2 (a), the pixels are represented as d_1, d_2, d_3 and d_4. The present paper considered texton shades if three or more pixels have the same intensity levels. This rule derives five texton shapes denoted as T_1, T_2, T_3, T_4 and T_5 as shown in Fig.2.

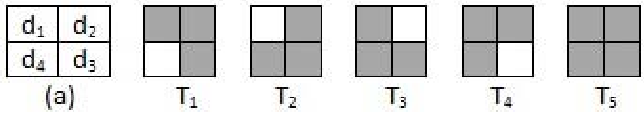


Figure 2 : Proposed 2×2 grid textons

IV. Deriving Different Shape Descriptor Indexes (SDI)

Hole shape (Index = 0): The TU with 0 represents a hole shape. The hole shape consists all 0's as shown in the Fig.3.

0	0
0	0

Figure 3 : Hole shape with SDI value *0*

Dot shape (Index =1): The TU with 1, 2, 4 and 8 represents a dot shape. The dot shape will have only a single 1 as shown in Fig.4.

1	0	0	1	0	0	0	0
0	0	0	0	0	1	1	0

Figure 4 : The four dot shapes with SDI value 1

Horizontal/Vertical line shape (Index =2): The two adjacent 1's results four different TU weights i.e. 3, 6, 9 and 12 and all of them represents a horizontal or vertical line as shown in Fig.5.

1	1	0	1	0	0	1	0
0	0	0	1	1	1	1	0

Figure 5 : Representation of horizontal / vertical lines with SDI value 2. Diagonal Line shape (Index= 3): The other two adjacent 1's with TU values 5 and 10 represents diagonal lines as shown in Fig.6.

0	1	1	0
1	0	0	1

Figure 6 : Representation of diagonal line with SDI value 3

Triangle shape (Index = 4): The three adjacent 1's with TU values 7, 11, 13 and 14 represents triangle shape as shown in Fig.7.

1	1	0	1	1	0	1	1
0	1	1	1	1	1	1	0

Figure 7 : Representation of triangle shape with SDI value 4

Blob shape (Index =5): TU 15 with all 1's represents a blob shape as shown in Fig.8.

1	1
1	1

Figure 8 : Representation of blob shape with SDI value 5

The advantage of SDI is they don't depend on relative order of texture unit weights and can be given in any of the four forms as shown in Fig.9 where the relative TU will change, but shape remains the same.

2^0	2^1	2^3	2^0	2^2	2^3	2^1	2^2
2^3	2^2	2^2	2^1	2^1	2^0	2^0	2^3

Figure 9 : Four different ways of assigning weights to TU

V. Derivation of Total Texton Shape Co-occurrence Matrix (TTSCM)

If the given image is colour convert into gray level image. Divide each 3×3 window into two separate units by comparing neighbouring pixel value with the centre pixel as shown in fig.10 for deriving Binary Cross Texture Unit Element (BCTUE) and Binary Diagonal Texture Unit Element (BDTUE)[2,3,4,5]. As shown in Fig. 10(a) a 3×3 neighbourhood will have 8 neighbouring pixels and are divided into two sets of cross and diagonal sets with four pixels of binary values as shown in Fig.10(b & c), by following the equation 6. Represent BCTUE and BDTUE in the form of two separate 2×2 grids as shown in Fig.11.

$$bi = \begin{cases} 0 \; if \; S(Pc - Pi) < 0 \\ 1 \; if \; S(Pc - Pi) \geq 0 \end{cases} \quad (6)$$

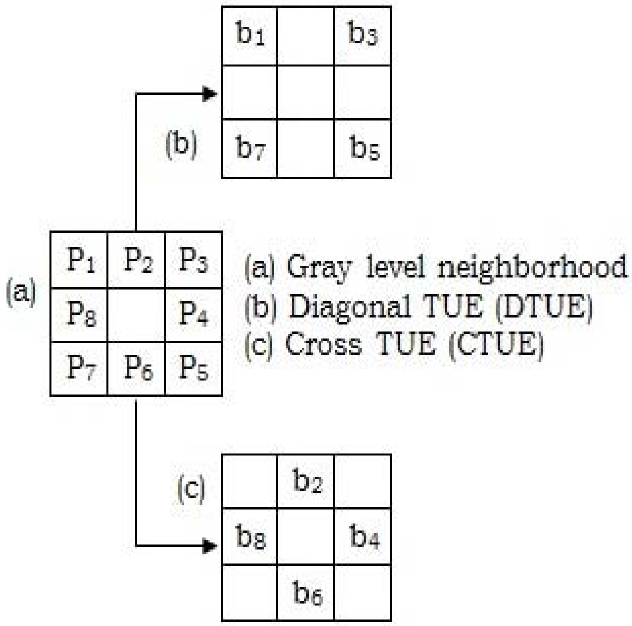


Figure 10 : Representation of 3×3 neighborhood and its BDTUE and BCTUE

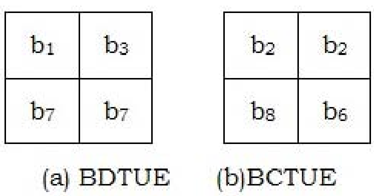


Figure 11 : Representation of 2×2 grid BDTUE and BCTUE

Derive Shape Descriptor Indexes (SDI) on BDTUE and BCTUE for deriving Diagonal SDI (DSDI) and Cross SDI (CSDI) is as shown in Fig.12 and Fig.13.

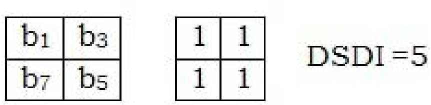


Figure 12 : BDTUE in the form 2×2 grid and derived DSDI

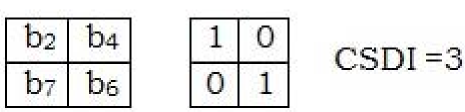


Figure 13 : BCTUE in the form 2×2 grid and derived CSDI

Repeating above process on entire image by convolving in an overlapped manner forms two separate images namely Cross Shape Descriptor Index (CSDI) and Diagonal Shape Descriptor Index (DSDI). SDI on a 2 × 2 grid ranges from 0 to 5 therefore the pixel grey level values of CSDI and DSDI images ranges from 0 to 5 only.

For forming Total Shape Descriptor Index (TSDI) image add CSDI and DSDI images as shown in Fig.14 and the pixel grey level values of TSDI image ranges from 0 to 10. Now derive textons on TSDI to form Total Texton Shape Matrix (TTSM) image. Finally construct co-occurrence matrix on TTSM that which leads to the formation of Total Texton Shape co-occurrence Matrix (TTSCM) on which GLCM features with 0°, 45°, 90°, and 135° are derived. For efficient discrimination algorithm is derived based on the feature set values of TTSCM.

1	0	0	0	0
1	2	5	1	3
1	5	5	3	3
2	0	4	4	0
2	3	4	4	4

(a)CSDI Image

+

0	3	0	0	0
0	2	3	0	3
2	3	2	2	1
0	0	4	1	0
0	4	5	0	5

(b)DSDI Image

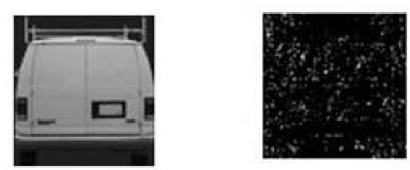
→

1	3	0	0	0
1	4	8	1	6
3	8	7	5	4
2	0	8	5	0
2	7	9	4	9

(c)TSDI Image

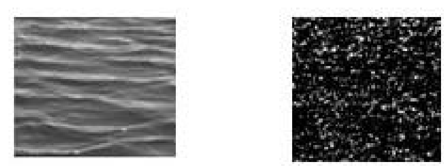
Figure 14 : Formation mechanism of TSDI image

The Fig.15, 16 and 17 represents TSDI for Car, Water and Elephant images respectively.



(a) (b)

Figure 15 : (a) Car image (b) TSDI of (a)



(a) (b)

Figure 16 : (a) Water image (b) TSDI of (a)

(a) (b)

Figure 17 : (a) Elephant image (b) TSDI of (a)

VI. Results and Discussions

The average of contrast, correlation, energy and homogeneity features set values on TTSCM are evaluated with a distance of one and with an orientation of 0°,45°,90° and 135° are tabulated in Table 1, 2 and 3 for the Car, Elephant and Water texture images collected from Google data base respectively. A sample texture images of Car, Water and Elephant are shown in Fig.18. Based on feature set values of TTSCM images, Algorithm 1 is derived. Discrimination results are tabulated in Table 4 along with a bar graph shown in Fig.19. The Table 5 compares discrimination rates of our earlier methods Texton based Cross Shape Descriptor Index (TCSDI) Texton based Diagonal Shape Descriptor Index (TDSDI) [2,4] with the current method TTSCM approach of this paper. The corresponding bar graph representation is shown in Fig.20.

The proposed TTSCM obtained high discrimination rate over our earlier TCSDI and TDSDI methods. This is because the TTSCM represent the SDI of the entire image instead of two separate or partial images of TCSDI and TDSDI.

Figure 18 : Images of car, water and Eelephant textures

Table 1: Average GLCM feature values with 0°, 45°, 90° and 135° for TTSCM of Car images

Texture number	Contrast	Correlation	Energy	Homoge neity
C_1	12.655	0.5969	0.174	0.6707
C_2	13.326	0.5751	0.128	0.6317
C_3	12.499	0.6052	0.162	0.6671
C_4	11.465	0.6269	0.188	0.6838
C_5	14.144	0.5386	0.112	0.6081
C_6	13.939	0.5388	0.081	0.5848
C_7	13.542	0.5639	0.117	0.6208
C_8	13.812	0.5804	0.115	0.6377
C_9	14.126	0.5469	0.122	0.6269
C_10	11.662	0.6075	0.235	0.7022

Table 2 : Average GLCM feature values with 0°, 45°, 90° and 135° for TTSCM of Elephant images

Texture numbe r	Contras t	Correlat ion	Energy	Homog eneity
E_1	9.159	0.3525	0.032	0.4971
E_2	9.809	0.3369	0.0354	0.5044
E_3	9.129	0.3472	0.0375	0.5137
E_4	9.268	0.3631	0.0375	0.5165
E_5	8.801	0.3546	0.0387	0.5187
E_6	9.187	0.3343	0.0371	0.5156
E_7	7.254	0.2813	0.0474	0.5335
E_8	6.479	0.2645	0.0509	0.5414
E_9	12.69	0.4056	0.0324	0.5063
E_10	6.252	0.2921	0.0495	0.5478

Table 3 : Average GLCM feature values with 0°, 45°, 90° and 135° for TTSCM of Water images

Texture numbe r	Contras t	Correlati on	Energy	Homog eneity
W_1	18.74	0.4686	0.0402	0.5306
W_2	16.83	0.3171	0.0327	0.4965
W_3	15.08	0.328	0.0352	0.5022
W_4	17.71	0.3615	0.0345	0.4859
W_5	18.45	0.4389	0.0301	0.5002
W_6	12.03	0.314	0.0359	0.5031
W_7	16.48	0.4387	0.0317	0.5013
W_8	15.26	0.5095	0.0408	0.5462
W_9	16.43	0.3591	0.0316	0.5024
W_10	19.39	0.3411	0.027	0.4851

Algorithm 1: Discrimination algorithm using the proposed TTSCM method.

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```
Begin
    if contrast >=1 && contrast <=10
        Print "Texture image is    Elephant"
    else if contrast > 10 && contrast <=15
        Print "Texture image is Car"
    else if contrast >15 && contrast <=20
        Print "Texture image is Water"
End
```

Table 4 : Discrimination rates of the proposed TTSCM method

Texture Database	Discrimination rate (%) TTSCM method
Elephant	93
Car	100
Water	86
Average Discrimination rate	93

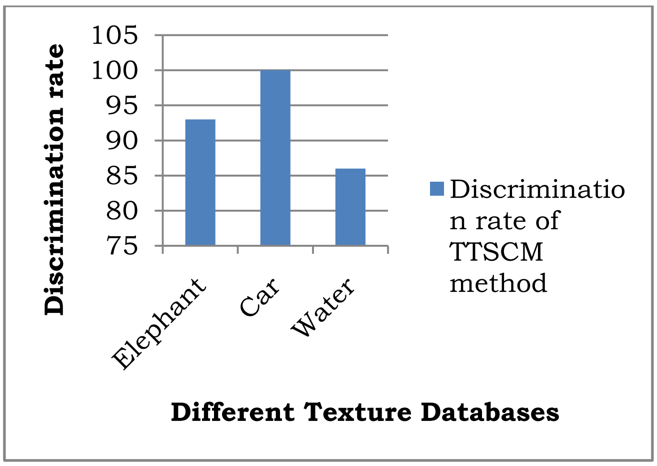

Figure 19 : Bar graph representation for Discrimination rates

Table 5 : Discrimination rates of the earlier and proposed method

Methods	Average discrimination rates (%)
TCSDI	84.33
TDSDI	88.66
TTSCM	93

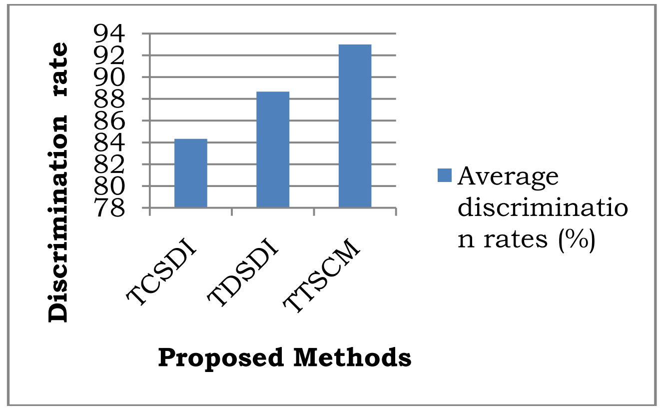

Figure 20 : Bar graph representation of proposed methods

VII. Conclusion

The present paper derived TTSCM image by adding CSDI and DSDI images. By this TTSCM captured all local shape features. The present paper compared the discrimination rates of TCSDI, TDSDI and TTSCM approaches. The results clearly indicate the high discrimination rates of TTSCM over our earlier TCSDI and TDSDI methods. The TSDI represents efficient border without any disturbances when compared to CSDI and DSDI images. This is because TTSCM forms only one SDI image on the original image instead of two different SDI namely, i) TCSDI ii) TDSDI. The intensity values of TSDI image range from 0 to 10. Moreover TTSCM reduces the formation of two GLCM on the original image one representing the cross and other representing the diagonal features.

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Statistical Analysis of Fractal Image Coding and Fixed Size Partitioning Scheme

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Abstract- Fractal Image Compression (FIC) is a state of the art technique used for high compression ratio. But it lacks behind in its encoding time requirements. In this method an image is divided into non-overlapping range blocks and overlapping domain blocks. The total number of domain blocks is larger than the range blocks. Similarly the sizes of the domain blocks are twice larger than the range blocks. Together all domain blocks creates a domain pool. A range block is compared with all possible domains block for similarity measure. So the domain is decimated for a proper domain-range comparison. In this paper a novel domain pool decimation and reduction technique has been developed which uses the median as a measure of the central tendency instead of the mean (or average) of the domain pixel values. However this process is very time consuming.

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GJCST-F Classification: I.3.3

STATISTICALANALYSISOFFRACTALIMAGECODINGANDFIXEDSIZEPARTITIONINGSCHEME

Strictly as per the compliance and regulations of:

Statistical Analysis of Fractal Image Coding and Fixed Size Partitioning Scheme

Swalpa Kumar Roy [α], Samir Kumar Bandyopadhay [σ], Debnath Bhattacharyya [ρ] & Tai-Hoon Kim [ω]

Abstract- Fractal Image Compression (FIC) is a state of the art technique used for high compression ratio. But it lacks behind in its encoding time requirements. In this method an image is divided into non-overlapping range blocks and overlapping domain blocks. The total number of domain blocks is larger than the range blocks. Similarly the sizes of the domain blocks are twice larger than the range blocks. Together all domain blocks creates a domain pool. A range block is compared with all possible domains block for similarity measure. So the domain is decimated for a proper domain-range comparison. In this paper a novel domain pool decimation and reduction technique has been developed which uses the median as a measure of the central tendency instead of the mean (or average) of the domain pixel values. However this process is very time consuming. Thus another technique has been suggested which heuristically eliminates the empty domain classes. Experiments on some standard image data shows that the proposed technique improves the PSNR of the decompressed image when compared with baseline fractal image compression (BFIC) and comparable with other scheme proposed till date.

Keywords: fractal image compression, fishers classification, hierarchi-cal classification, median, DCT, IFS, PIFS, PSNR.

I. Introduction

A major objective of image coding is to represent digital images with as few bits as possible while preserving the level of intelligibility, usability or quality required for the application. Fractal image coding has been used in many image processing applications such as feature extractions, image watermarking, image signatures, image retrievals and texture segmentation The theory of fractal based image compression using iterated function system (IFS) was first proposed by Michael Barnsley [2]. A fully automated version of the compression algorithm was first developed by Arnaud Jacquin, using partitioned IFS (PIFS) [8]. Jacquins FIC scheme is called the baseline fractal image compression (BFIC)[2, 3]. This method exploits the fact that real world images are highly self-similar [4] i.e. diferent portions of an image resemble each other. Also there is self-similarity at every scale. Fractal com-pression is an asymmetric process. Encoding time is much greater compared to decoding time, since the encoding algorithm has to repeatedly compare a large number of domains with each range to _nd the best-match. Thus the Jacquin's Scheme lacks behind other image compression techniques like jpeg (DCT [12, 22, 24] based image compression) or wavelet based technique. Thus the most critical problem this technique faces is its slow compression step. A huge amount of research has been done to improve the performance of this technique which mainly includes:- Better partitioning scheme; Efective encoding scheme; Reducing the number of domains in the domain pool; Reducing number of domain and range comparison or better classification;

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II. Fractal Image Compression

a) Mathematics

The mathematical analogue of a partition copying machine is called a parti-tion iterated system (PIFS) [6]. The definition of a PIFS is not dependent on the type of transformations, but in this paper we will use affine transfor-mations. There are two spatial dimensions and the grey level adds a third dimension, so the transformations W_i are form,

$$W_i\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} a_{i,1} & a_{i,2} & 0 \\ a_{i,3} & a_{i,4} & 0 \\ 0 & 0 & 0 \end{bmatrix} \times \begin{bmatrix} x \\ y \\ z \end{bmatrix} + \begin{bmatrix} d_{i,1} \\ d_{i,2} \\ o_i \end{bmatrix} \quad (1)$$

An affine transformation in Rn is a function consisting of a linear trans-formation and translation in Rn. Affine transformations in R2, for example, are of the form:-

$$W(x; y) = (ax + by + e; cx + dy + f) \quad (2)$$

Where the parameters a, b, c, and d form the linear part, which deter-mines the rotation, skew, and scaling; and the parameters e and f are the translation distances in the x and y directions, respectively.

A domain and a range is compared using an RMS metric [6]. Given two square sub-images containing n pixel intensities, $a_1; a_2;\ldots,a_n$ (from the domain)and $b_1; b_2;\ldots,b_n$ (from the range), with contrast s and brightness o between them, the RMS distance between the domain and the range is given by

$$R = \sum_{i=1}^{n}(s.a_i + o - b_i)^2 \quad (3)$$

This gives the settings for contrast scaling s and brightness o that make the affinely transformed a_i values to have the least squared distance from the b_i values. The minimum value of R occurs when the partial derivatives with respect to s and o are zero. Solving the resulting equations will give the coe_cients s and o as shown below in Eq. 4 and 5.

$$s = \frac{[(\sum_{i=1}^{n} d_i r_i) - (\sum_{i=1}^{n} d_i)(\sum_{i=1}^{n} r_i)]}{[n(\sum_{i=1}^{n} d_i^2) - (\sum_{i=1}^{n} d_i)^2]} \quad (4)$$

$$o = \frac{1}{n}[\sum_{i=1}^{n} b_i - s\sum_{i=1}^{n} a_i] \quad (5)$$

and

$$d_{rms}(f \cap (R_i x I), w_i(f)) \quad (6)$$

Detailed mathematical description of IFS theory and other relevant results can be found in (Barnsley, 1988; Barnsley and Hurd, 1993; Edgar, 2007, Falconer, 2013)[2, 3, 7].

b) The Pain

As mentioned in section 1, a very large number of domain-range comparisons is the main bottleneck of the compression algorithm [6]. For example, consider an image of size 512 x 512. Let the image be partitioned into 4 x 4 non-overlapping range blocks. There will be total 2^{14} = 16384 range blocks. Let the size of domain blocks be 8 x 8 (most implementations use domain sizes that are double the size of range). The domain blocks are overlapping. Then, for a complete search, each range block has to be compared with 505 x 505 = 255025 domain blocks. The total number of comparisons will be around 232. The time complexity can be estimated as Ω (2^n):

III. Partition Schemes

The first decision to be made when designing a fractal coding scheme is in the choice of the type of image partition used for the range blocks [12]. The domain blocks need to be transformed to cover range blocks. Thus this restricts the possible sizes and shapes of the domain blocks. A wide variety of partitions have been investigated, the majority being composed of rectangular blocks.

a) Fixed Size Partitioning

This is the simplest of all partitioning schemes that consists of fixed size square blocks [5] depicted in Fig. 1(a). This type of block partition is successful in transform coding of individual image blocks since an adaptive quantization mechanism is able to compensate for the varying activity levels of diferent blocks, allocating few bits to blocks with little detail and many to detailed blocks [12].

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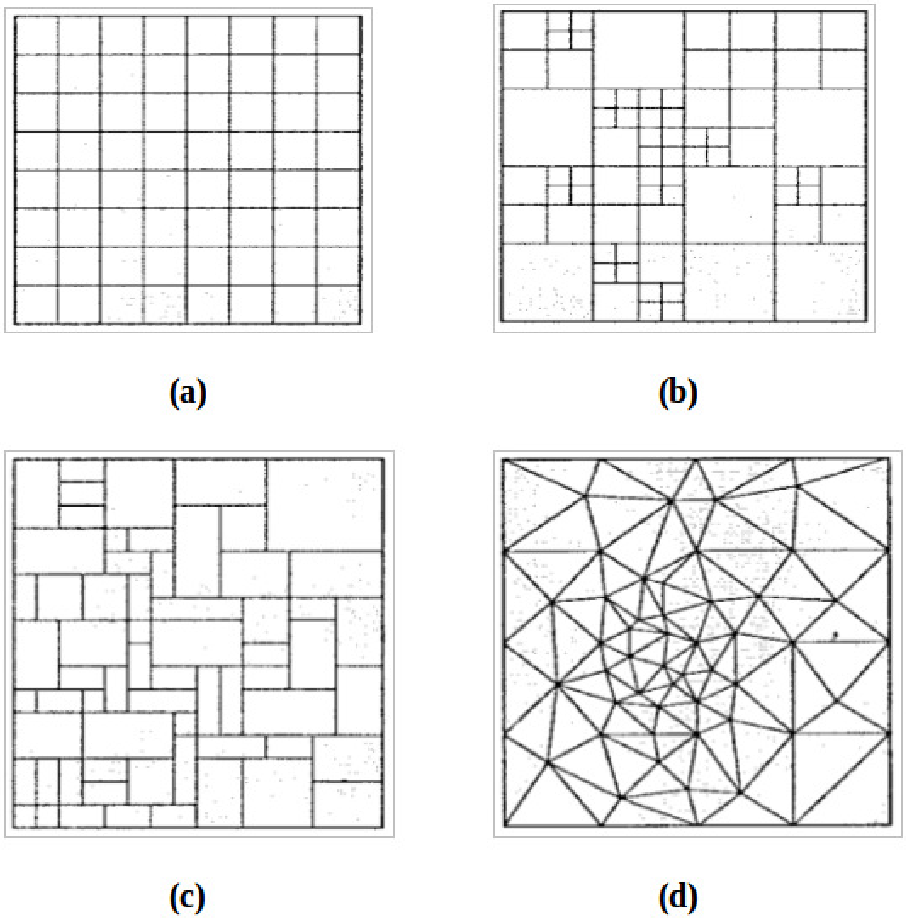

Figure 1: Partition Schemes (a) Fixed size blocks (b) Quadtree partitioning (c) Horizontal-Vertical partitioning (d) Triangular blocks

b) Quadtree Partitioning

The quadtree partition shown in Fig. 1(b) recursively splits of selected image quadrants, which enables the resulting partition to be represented by a tree structure in which each non-terminal node has four descendants. The usual top-down construction starts by selecting an initial level in the tree, corresponding to some maximum range block size, and recursively partitioning any block for which a match better than some preselected threshold is not found.

c) Horizontal-Vertical Partitioning

This is a variant of the quadtree partitioning scheme in which a rectangular image [26] is partitioned shown in Fig. 1(c) either horizontally or vertically to form two new rectangles. The partitioning repeats recursively until a covering tolerance is satis_ed, as in the quadtree scheme. This scheme is more exible, since the position of the partition is variable.

d) Triangular Partitioning

This is a specialization of the polygon partitioning scheme in which the image is partitioned recursively into triangular blocks shown in Fig. 1(d).

Algorithm 1 Basic Fractal image encoding algorithm

1: **procedure** BFIC
2: *Loop*:
3: Range Block for every range block R_i, $i = 1,2,....,N_R$,do
4: *Loop*:
5: *Domain Search* for every domain block D_j, $j = 1,2,....,N_D$, do
6: *Loop a*: For every a_k, $k = 1,2,....,m$, do
7: *Loop b*: For every b_l, $l = 1,2,....,n$, do
8: *Error Calculation*

$$error = \| a_k D + b_l I - R \|^2 \quad (7)$$

IV. Problems of Exhaustive Search

As describe in section 1, a very large number of domain-range comparison is the main dificulty of the fractal encoding algorithm. Experiments on standard images, consider an image of size N x N. Let the entire image is partitioned into M x M non-overlapping range blocks. The total number of range blocks are given by $(\frac{N}{M})^2$ Most implementation use the size ofdomain block is twice larger than the range block i.e. 2 x M. Let the total number of domain blocks are given by (N - 2M + 1)^2. The domain blocks are overlapping. In Algorithm 1, there are nested LOOP in the process and for every step we need to calculate the error defined by Eq. 6. The computation of best matching between a range block and a domain block is O(M^2). Considering M to be a constant, the Fig. 2 Domain search of a range computation complexity domain search for a range is O(N^4), which is approximately exponential time. Encoding time can be reduced by reducing the size of the domain pool [1, 25].

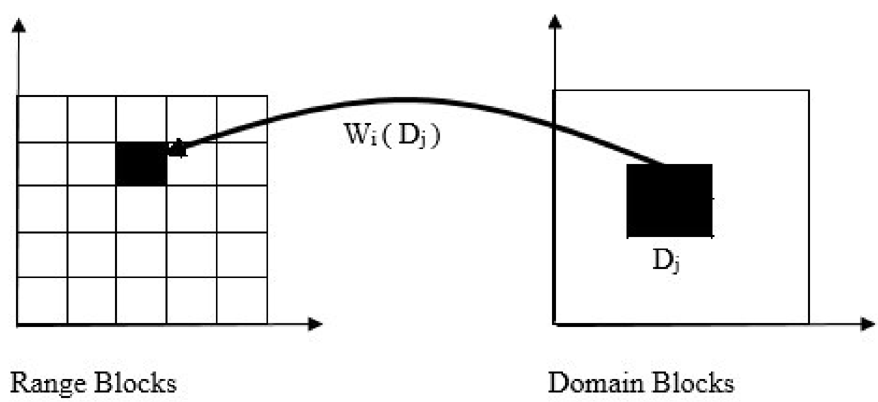

Figure 2 : Domain Search of a Range

V. Fisher's Classification Scheme

The domain-range comparison step of the image encoding is very computationally intensive. We use a classification scheme in order to reduce the number of domains blocks compared with a range blocks. The classification scheme is the most common approach for reducing the computational complexity. In such classification schemes, domain blocks are grouped in to number of classes according to their common characteristics. For fractal image decoding, the decoding will be done in less number of comparisons, so that it would become the faster computations. While reconstructing, the pixels of each range with the average of their corresponding domain are sub-stituted. This provides a very high quality image in a few iterations withoutany change in compression ration [20]. Fisher's classification scheme [6] is as follows: A square sub-image (domain or range) is divided into upper-left, upper-right, lower-left, and lower right quadrants, numbered sequentially. On each quadrant, values Ai (proportional to mean pixel intensity) and V_i (proportional to pixel intensity variance) are computed. If the pixel values in ith quadrant are r_1^i, r_2^i, $r_3^i, \ldots, r_n^i$ for i = 0,1,2,3 we compute.

$$A_i = \sum_{j=1}^{n} r_j^i \quad (8)$$

and

$$V_i = \sum_{j=1}^{n} (r_j^i)^2 - A_i \quad (9)$$

After that it is also possible to rotate the sub-image (domain or range) such that the Ai are ordered in one of the following three ways:

Major Class 1: $A_1 \geq A_2 \geq A_3 \geq A_4$
Major Class 2: $A_1 \geq A_2 \geq A_4 \geq A_3$
Major Class 3: $A_1 \geq A_4 \geq A_2 \geq A_3$

These orderings constitute three major classes and are called canonical orderings. Under each major class, there are 24 subclasses consisting of $^4P_4$ orderings of V_i. Thus there are 72 classes in all. In this paper, we refer to this classification scheme as FISHER72.

According to the fisher that the distribution of domains across the 72 classes was far from uniform [14]. So fisher went on to further simplify the scheme of 24 classes in the FISHER72 classification. Fisher concluded: the improvement attained by using 72 rather than 24 classes is minimal and comes at great expense of time [6]. In this paper, we refer to this modified form of FISHER72 as FISHER24 using this concepts a hierarchical classification is proposed by N. Bhattacharya et al. [14]. We simply take the advantages of hierarchical classification [14] of sub-images and combining with fixed size partition to reduce the encoding time.

VI. Proposed Hierarchical Classification Scheme

Fisher used values proportional to the mean and the variance of the pixel intensities to classify the domain and range image. In our proposed schemes Algorithm 2 [13], we use only the sum of pixel intensities of fixed parts of domain (8 x 8) or range (4 x 4) then classify those fixed part.

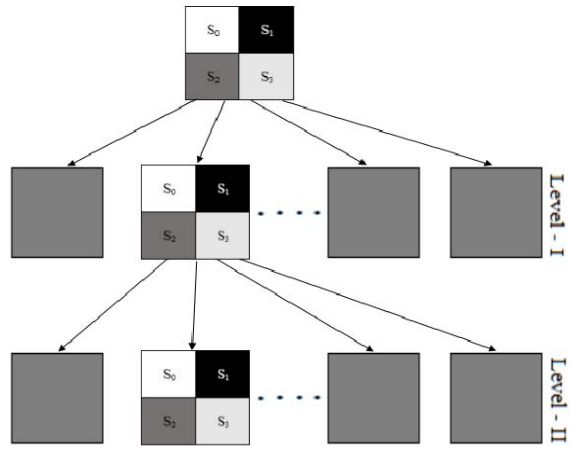

Figure 3 : Domain pool has domains with fixed size of 8 x 8 and 24 classes (child) from domain of size 8 x 8 in Level I. There are 331776 classes (child) for every 24 classes in Level I create Level II. Every nodes of Level II have 331776 array cells point to a list of domains together in that class.

According to the proposed Algorithm 2 [13] compression, at first the domain pool is being related data structures are defined as in the Fig. 3. Domains are first classified by their size, then into Level-I, according to pixel- value sum of 4 quadrants, and finally into Level-II, according to pixel-value sum of 16 sub quadrants. After two Levels of classification domain is place in list of point to array known as domain pool Fig. 3.

In the proposed compression algorithm, when searching the domain pool for a best-match with a particular range, only those domains that are in the same Level-II and same class.

Algorithm 2 A Speeding Up Fractal Image Compression using Fixed Size Partition and Hierarchical Classification of Sub-images

1: **procedure** PROPOSED

2: Range Pool (R) The image is partitioned into non-overlapping Fixed size range (4 x 4).

3: Domain Pool (D) The image is partitioned into overlapping Fixed size domain (8 x 8).

4: *Loop* Each range block is then divided into upper left, upper right, lower left and lower right each part is known as quadrant (S_i).

$$S_i = \sum_{j=1}^{n} r_j^i \tag{10}$$

5: Thus we observe that there can be in total ${}^4P_4$ (24) permutations possible, based on the relative ordering of the summation of pixel intensities and a corresponding class (class - 1 to 24) is assigned to it.

6: Each of the quadrant is further sub-divided into four sub-quadrants.

7: The sum of pixel values $S_{i,j}$ (i = 0,1,2,3; j = 0,1,2,3) for each sub-quadrant are calculated.

8: We again obtain the classes each of the sub-quadrants (class 1 to 24) i.e. for a particular a range /domain block we obtain 16 sub-quadrants or the domain pool can be classified into $24^4 = 331776$ classes.

a) PROPOSED TECHNIQUE - I (P-I)

In the domain pool creation phase, Jacquin [10] selected squares cantered on a lattice with a spacing of one-half of the domain size. It is convenient to select domains with twice the range size and then to sub-sample or average groups of 2 x 2 pixels to get a reduced domain with same number of pixels as the range as shown in Fig. 4.

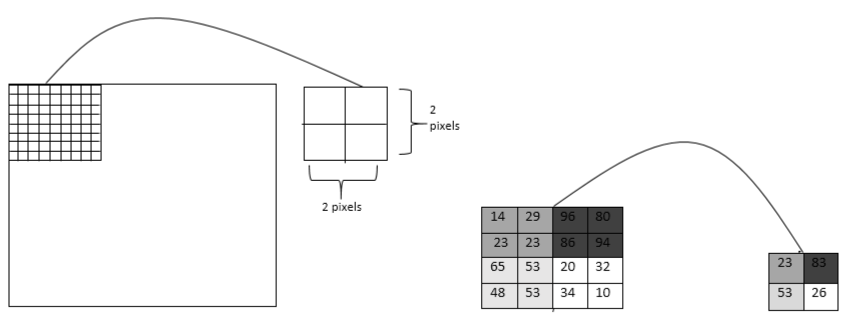

Figure 4 : (left) Each pixel of the domain block is formed by averaging 2 x 2 pixel of the image (Jacquins scheme). (right) Reduced domain pool formed by calculating the median values of each 2 x 2 block

In our proposed technique we calculate the median of the 2 x 2 pixel blocks instead of taking the average or mean of the pixels. It produces better results as median is a better measure (or statistic) of the central tendency of data. This is because the mean is susceptible to the inuence of outliers (i.e. an extreme value that difers greatly from other values). So, this will nullify the efect outlier pixel value among the four pixels and produce a value that is closer to the majority of pixel values.

The reduced domain pool thus contains the median values of the 2 x 2 blocks.

b) Proposed Technique - II (P-II)

This is an add-on to the Algorithm 2 [13] that has been proposed above, to reduce the number of domain-range comparisons.

Each of the four quadrants of a domain are assigned a number between 1 and 24 gives 24^4 =331776 cases in total shown in Fig. 5, for the entire sub-image. A number between 1 and 331776 that uniquely identifies this

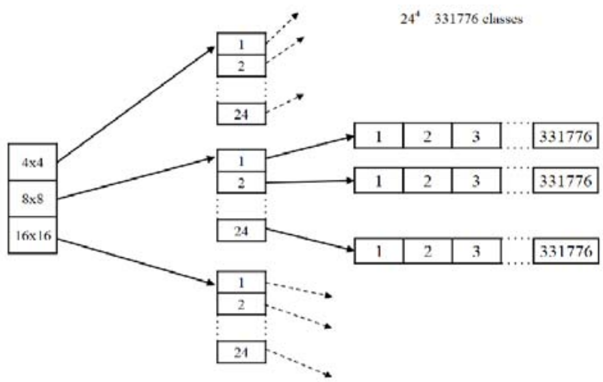

Figure 5 : Proposed classification scheme

particular case is assigned to this sub-image [13]. Thus there are a lot of classes which are left empty (i.e. no domains are assigned to it).

The main idea behind this procedure is to heuristically eliminate the null classes or the classes which don't contain any domain.

VII. Results and Discussions

a) Tools

Five standard 512 x 512 x 8 grayscale images have been used to test the proposed techniques 5 and also for comparison with FISHER24 classification scheme and modified Hierarchical classification [14].

The algorithm was implemented in C++ programming language running on a PC with following specifications: CPU Intel Core 2 Duo 2.0 GHz; RAM 4 GB; OS Ubuntu 14.4 64-bit.

b) Research Result

The Comparison of compression time for the five image files have been made in Table 1. The comparison of PSNRs for the same image are given in Table 2 while space saving are given in Table 3. The pictorial representation of compression times, PSNRs, space savings and decoding times are illustrated in Figures 6, 7, and 8 respectively.

Table 1: Comparison of encoding time(s) of Images

Image data	BFIC	Paper [14]	Proposed
Aerial	291.081	72.781	0.451
Baboon	304.790	84.618	0.437
Boat	309.488	85.425	0.439
Bridge	322.336	88.303	0.441
Lenna	283.244	72.949	0.492

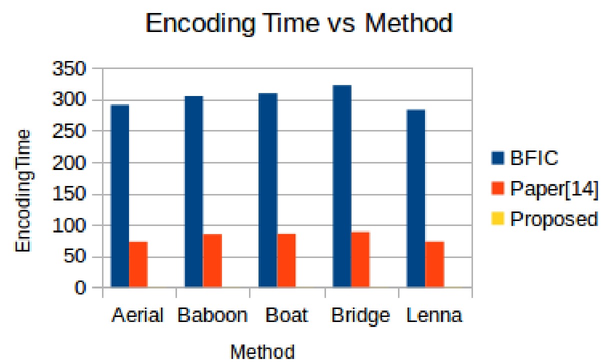

Figure 6 : Graphical comparison of Compression Time (in seconds)

Table 2 : Comparison of PSNRs of Images(in dB)

Image data	BFIC	Paper [14]	Proposed
Aerial	38.67	26.32	23.74
Baboon	36.36	25.61	25.61
Boat	41.93	31.00	26.01
Bridge	39.46	27.43	25.62
Lenna	41.63	32.33	29.22

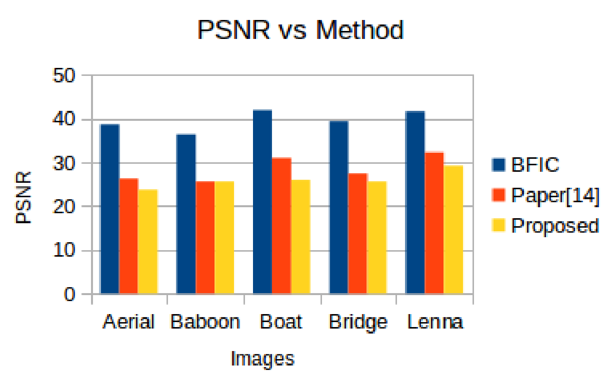

Figure 7: Graphical comparison of PSNR (dB) of Images

Table 3 : Comparison of Space Savings (%) of Images

Image data	BFIC	Paper [14]	Proposed
Aerial	60.94	64.63	91.71
Baboon	53.80	59.36	92.07
Boat	56.76	57.27	90.43
Bridge	56.12	56.34	90.40
Lenna	64.03	64.23	90.23

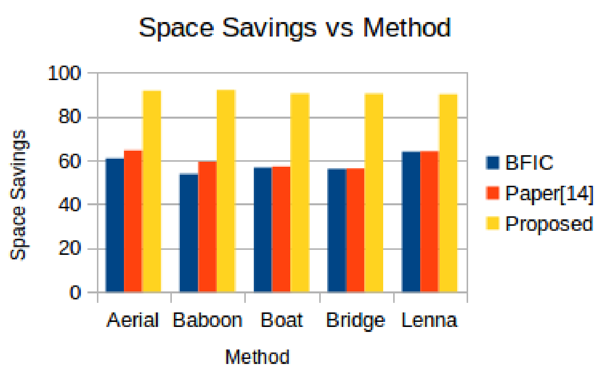

Figure 8 : Graphical comparison of Space Saving (%)

c) *Extended Experimental Result*

In the previous proposed [13] technique we used the minimum domain block size of 8 x 8 pixels. The PSNR has been improved by reducing the minimum domain block size to 4 x 4 pixels (range blocks are 2 x 2). As a trade-of the encoding time is slightly increased. This is because, as the block domain size has been reduced, the no. of domains in the domain pool increases. But the overall efect on PSNR outweighs the increased encoding time. So this method is convenient. The results have been shown in the tables below based on the comparison of Fisher's method, P-I and P-II.

We test the extended technique proposed-I and proposed-II with standard Lenna image (512 x 512 x 8). For every range block, we use 3 bits to store the scaling parameter ai in Eq. 3 and 1 byte to store the mean of range block ~r. In Fixed size partitioning structure, we considered 2 levels which starts 4 X 4 domain block size and 2 x 2 range block size. We see that, P-I and P-II fractal coding technique is very fast, when PSNR = 30, it only takes only 1.371 s (P-I) and 1.370 s (P-II)

To compare our proposed technique with the result of fast method reported by Tong and Wong [27]. Tong and Wong improved the algorithm proposed by Saupe [17]. To comparison of Tong and Wong, Saupe and our method for Baboon(512 x 512 x 8) shown in Table. 7.

The Comparison of compression time for the six image files have been made in Table 4. The comparison of PSNRs for the same image are given in Table 5 while space saving are given in Table 6. The pictorial representation of compression times, PSNRs, space savings and decoding times are illustrated in Figures 10, 11, and 12 respectively. Figure 13 show the close up of Standard original images, decoded images after using existing as well as proposed P-I and P-II.

Table 4 : Comparison of encoding time(s) of Images

Image data	Fisher	P-I	P-II
Aerial	147.441	1.373	1.310
Baboon	150.429	2.211	1.988
Boat	160.219	2.098	1.910
Bridge	175.924	2.171	1.798
Lenna	193.066	1.371	1.370
Peppers	150.112	1.435	1.211

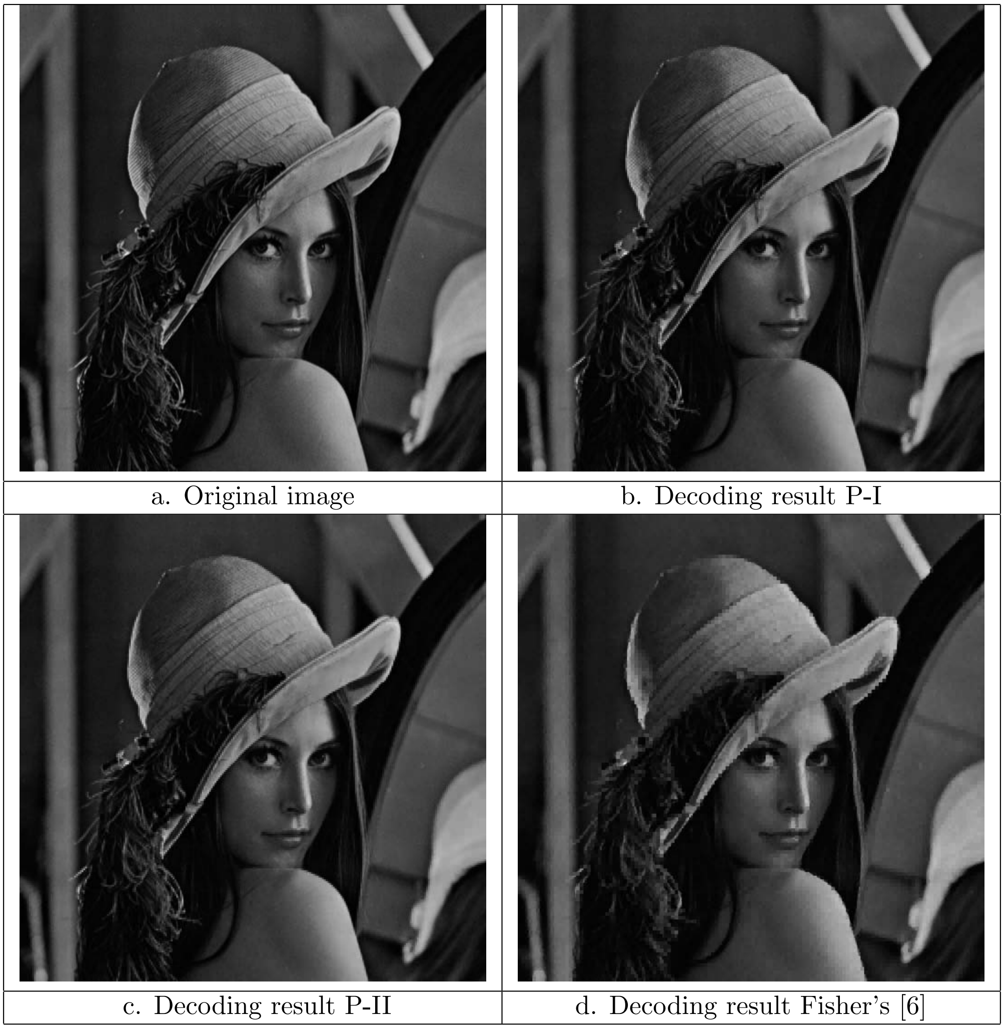

Figure 9 : Experimental Results: a. Original image of Lenna (512 x 512 x 8)
b. Decoding result using P-I, PSNR = 30.95 dB, compression time = 1.371 s
c. Decoding result using P-II PSNR = 30.95 dB, compression time = 1.370
s d.Decoding result using Fisher's PSNR = 30.60 dB,compression time =193.066s

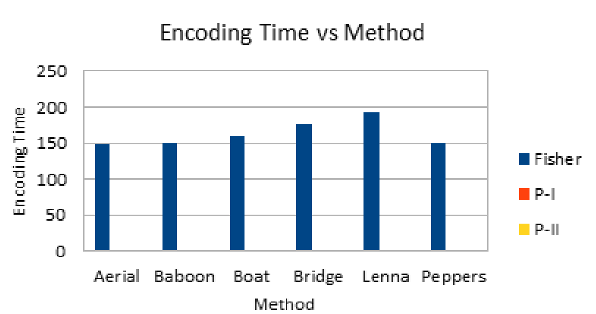

Figure 10 : Graphical comparison of Compression Time (in seconds)

Table 5 : Comparison of PSNRs of Images(in dB)

Image data	Fisher	P-I	P-II
Aerial	23.22	25.63	25.66
Baboon	23.40	26.55	26.87
Boat	28.44	28.46	28.50
Bridge	25.55	25.61	25.62
Lenna	30.60	30.95	30.95
Peppers	28.10	28.01	28.10

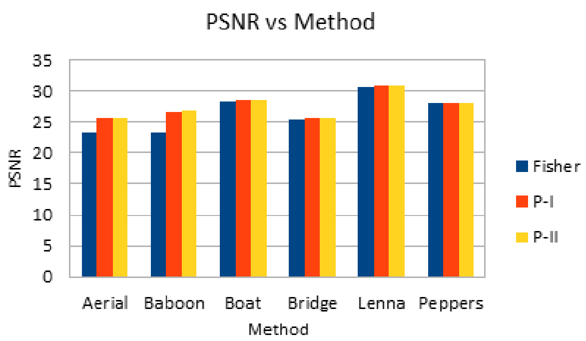

Figure 11 : Graphical comparison of PSNR (dB) of Images

VIII. Conclusions

The proposed Fractal image encoding by using fixed size partition and hierarchical classification of domain and range improves the compression time

Table 6 : Comparison of Space Savings (%) of Images

Image data	Fisher	P-I	P-II
Aerial	89.26	87.50	87.50
Baboon	89.39	83.49	83.49
Boat	89.49	80.25	80.25
Bridge	86.88	81.64	81.64
Lenna	89.58	85.58	85.58
Peppers	89.43	83.43	83.43

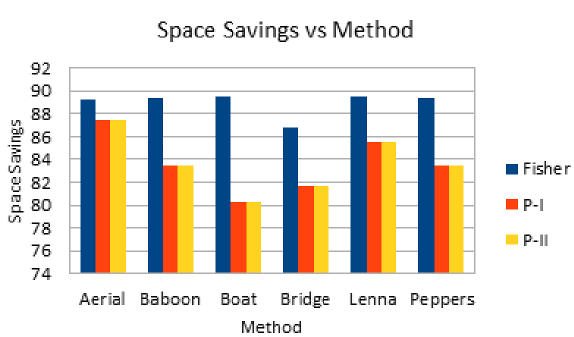

Figure 12 : Graphical comparison of Space Saving (%)

of images significantly, when compared to existing FISHER24 classification as well as our Fractal image compression using hierarchical classification of sub-image and quadtree partition. PSNRs of decoded images using proposed scheme compared FISHER24 and other papers till date are approximately closer.

Moreover PSNR has been improved using median as the measure of central tendency instead to mean while preparing the reduced domain pool. The encoding time is changed drastically by eliminating the empty classes using heuristic approaches.

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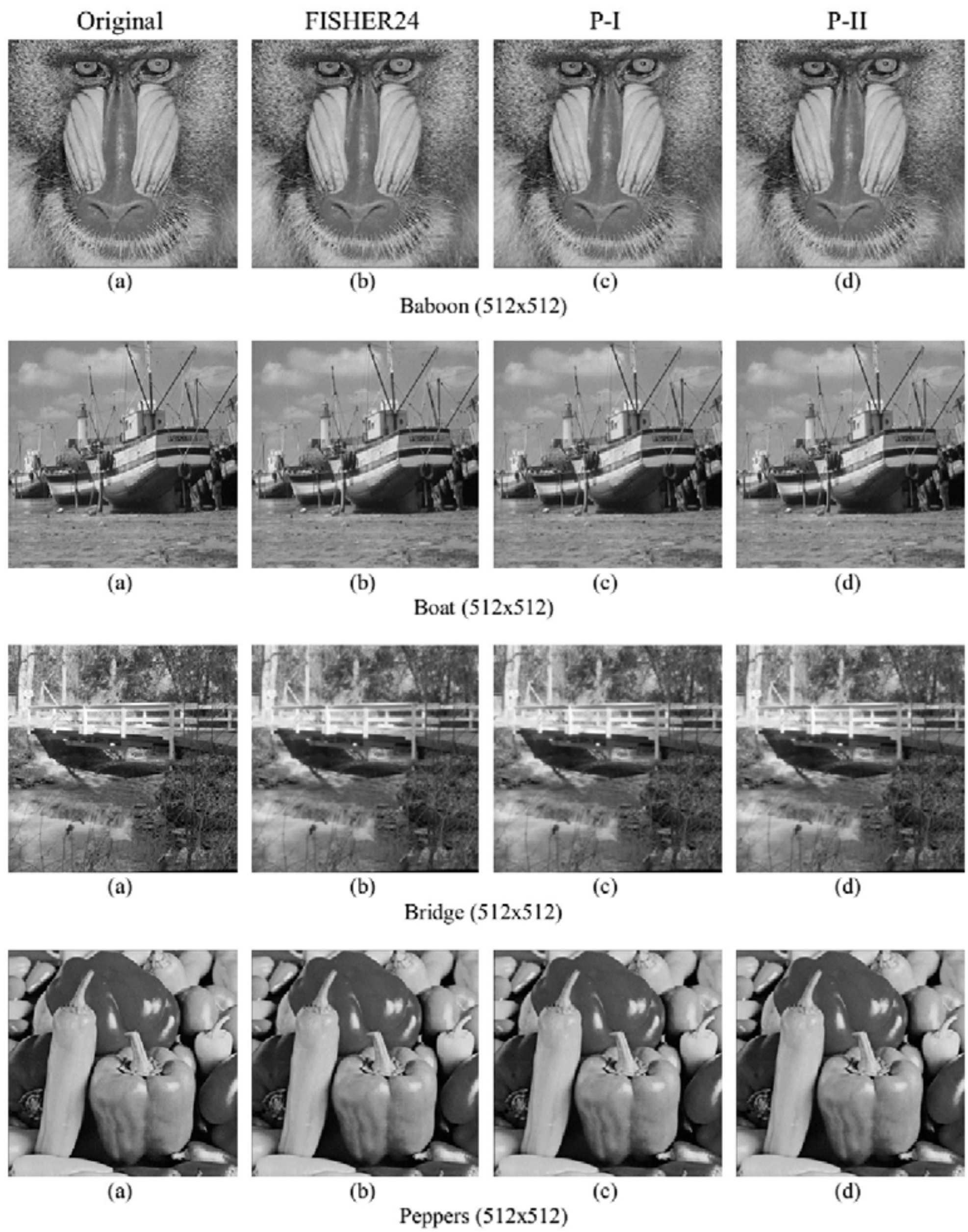

Figure 13 : Test images and results - Baboon, Boat, Bridge and Peppers. (a) Original image. (b) Result of using FISHER24 classification. (c) Result of using proposed P-I technique. (d) Result of using proposed P-II technique.

Table 7 : Comparison results of Baboon (512 x 512 X 8)

Method	PSNR(dB)	TIME(s)
Proposed-I (P-I)	26.55	2.211
Proposed-II (P-II)	26.87	1.988
Tong and Wong [27]	25.82	8
Saupe [17]	25.19	60

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Multi Spectral Band Selective Coding for Medical Image Compression

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Abstract- Medical image compression has recently evolved as an area of research for progressive transmission. The distance based medical diagnosis, demands for high quality imaging at faster data transfer rate. As the information's are highly informative, each pixel information defines a sample observation. Hence the coding in medical diagnosis need to be of higher accuracy than conventional image coding. In the approach of image coding multi spectral coding is developed as new coding approach to achieve the objective of higher visualization accuracy. With this observation in this paper a multi spectral coding using multi wavelet transformation is developed. The multi spectral coding is improved by a band selective approach using inter band correlation factor. The evaluation factors for such a coding technique are observed to be improved over conventional multi-spectral coding.

Index Terms: multi-spectral image coding, medical image compression, correlative band selection coding.

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I. Introduction

Medical image processing is a very important area of application in the field of medicine. Every year, terabytes of medical image data are generated through advance imaging modalities such as magnetic resonance imaging (MRI), computed tomography (CT), digital subtraction angiography (DSA), positron emission tomography (PET), X-rays and many more recent techniques of medical imaging. But storing and transferring these huge voluminous data could be a tedious job. In recent days, due to the hasty development of heterogeneous services in the field of image oriented applications, the future digital medical images and video applications finds several limitations with the available resources. In order to overcome these limitations medical images are getting transferred in the compressed/coded format. In medical image coding [2] diagnosis and analysis are doing well simply when coding techniques protect all the key image information needed for the storage and transmission. As in telemedicine, videos and the medical images are transmitted through advanced telecommunication links, so the help of medical image coding to encode and decode the data without any loss of useful information is immense importance for the faster transfer of the information. There are many medical image compression [1] techniques are available. In current approach of image coding, medical imaging finds it application in various real time applications. In the area of image coding for medical application [2], multi bit rate [3] applications are emerging. Conventional coding approaches are limited to their application due to network diversity issues. In various coding approaches the quality of coding allows partial coding for faster transportation. The conventional coding approaches developed for medical image coding are limited to multi stream bit coding at multi bit stream coding. In the case of multi bit rate [3] applications, the conventional multi bit-stream approaches are constrained and inefficient to the heterogeneity issue. At various resolutions and at various quality levels the multi bit stream coding allows partial decoding. In earlier, various scalable coding algorithms have been proposed at various international standards, but these earlier coding methods are applicable only for limited applications and also having limited decoding properties. The main problem of conventional multi bit stream approaches, inefficient and impractical due to the issue of wide varying requirements of user resources. The scalable codec's developed based on bit-level for this system allow optimal reconstruction of a medical image from an arbitrary truncation point within a single bit-stream. Recently, in the field of medical image compression, the wavelet transform has been developed as a cutting edge technology. Wavelet-based coding [4], [5], [6], [7] methods provide an improved picture quality at high compression ratios. To achieve the better compression performance, the wavelet filters should have the property of symmetry, orthogonality, higher approximation order and short support. Due to the constraints in the implementation, scalar wavelets can't satisfy all these enhanced properties. Compared with scalar wavelets, Multiwavelets [8], [9], [12] have several advantages and are generated by only a finite set of functions. One of the main advantage with multiwavelet, it can possess symmetry and orthogonality simultaneously [10], [11], whereas the scalar DWT can't possess these two properties simultaneously. These two properties of multiwavelet made it to offer the increased performance and also high degree of freedom compared with scalar wavelets, in image processing applications. Though multiwavelet are observed to be an effective approach for image compression coding, the

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resulting coefficients of such coding at very large due to multiple band decomposition. In the coding of multiwavelet though finer coefficients are derived it is observed that, among all the decomposed bands few bands reflect a similar spatial property as compared to others. With this observation, a selective band coding is proposed to reduce computational overhead. Band selection process is proposed as a developing approach in signal processing [13], wherein among 'K' band of decomposition, 'k-n' bands are selected as effective bands for processing. Such coding approach is termed as Adaptive band filters (ABF) [13]. To achieve a greater extent of coding efficiency, these selective bands are then coded for bit plane coding using a hierarchical coding. The coding approach is a hybridization of the zero block [14] and context coding [16]. To present the stated work, this paper is presented in 5 sections. The approach of multiwavelet coding for image compression is outlined in section 2. Section 3 presents the proposed adaptive coding approach. The proposed inter band hierarchical coding in presented in section 4. The obtained experimental results are presented in section 5. Section 6 outlines the conclusion made for the developed work.

II. Multiwavelet Coding

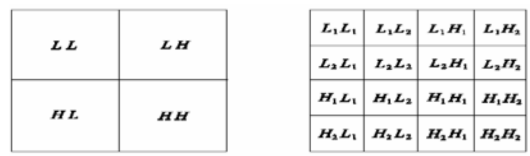
The wavelet transform is one of the signal transform technique, used commonly in image compression. An enhanced version of wavelet transform is multiwavelet transform. Multiwavelets and wavelets are almost similar but having some important differences. Wavelets have only two functions, wavelet function $\Psi(t)$ and scaling function $\Phi(t)$, whereas multiwavelet have multi scaling and multi wavelet functions [10]. The scaling function set for multiwavelet coding can be written as $\Phi(t) = [\Phi_1(t), \Phi_2(t) \ldots, \Phi_r(t)]^T$, where $\Phi(t)$ is a multi-scaling function. Similarly, the multiwavelet function set for multiwavelet coding can be written as $\Psi(t) = [\Psi_1(t), \Psi_2(t) \ldots, \Psi_r(t)]^T$. in general 'r' can be a large value, but the study on Multiwavelets to present date is for r=2[14]. The two scale equation for multiwavelet can be defined as

$$\phi(t) = \sqrt{2}\sum_{k=-\infty}^{\infty} H_k \phi(2t-k) \qquad \ldots (1)$$

$$\psi(t) = \sqrt{2}\sum_{k=-\infty}^{\infty} G_k \phi(2t-k) \qquad \ldots (2)$$

Where, $\{H_k\}$ and $\{G_k\}$ are matrix filters, i.e., H_k and G_k are 'r x r' matrices for each integer k. The filter coefficients of these filters provide more degree of freedom compared with scalar wavelets [4]. Due to this extra degree of freedom, the extra useful properties such as orthogonality, symmetry and higher order approximation can be incorporated into the multiwavelet filters.

Multiwavelets, compared with scalar wavelets, can achieve better level of performance with same computational complexity. A scalar wavelet transform decompose a 2-D image into four blocks for a single level of decomposition. Figure.1 (a) shows a single level decomposition using scalar wavelet and figure.1 (b) shows the subband decomposition using a Multiwavelet transform. In this coding, the H and L labels have subscripts representing the channel to which the data belongs to. For example, L_2H_1 represents the data from the first channel high pass filter in the horizontal direction and the second channel in low pass to the vertical direction.



(a) Scalar wavelets. (b) Multiwavelets.

Figure 1 : single level subband decomposition of a 2-D image

In the process of multi wavelet transform as the decompositions are made for each band isolately, the obtained coefficients are hence divided into further bands and processing over such 'n scale-bands' results in processing overhead. It could be observed that in multi level band decomposition, the lower level bands are derived from the upper level subbands, hence the obtained information formulate a quad-band decomposition. Wherein each subband is represented into 4 lower bands. As these 4 bands are finer details of a detail sub band these bands reflects a co-similarity among the 4 bands. Hence to reduce the coefficients and to retain the property of multi wavelet a selective coding for band selection is proposed. The approach of selective coding for band selection is defined in following section.

III. Selective-Mwvlt Coding

In various signal and image processing applications, refinement of a signal is made to achieve higher level of accuracy. In the process of band decomposition, it is observed that, finer details reveal more clear information's than the original processing signal. However as the band decomposition increases, the probability of redundancy among different bands increases. This redundancy of information increases the processing overhead, and intern makes the system slower. Hence it is required to have an adaptive band selection process for extracting the actual informative band from the processed bands. In the process of signal processing a adaptive band selection process for subband coding was made in [13]. However no such approach of band selection is observed in image coding. With reference to band selection process in this work the process of adaptive band selection is developed for multi wavelet coefficients. Considering the analysis and synthesis filter of the transformation as shown in figure 2, the generalized multiband decomposition can be shown as;

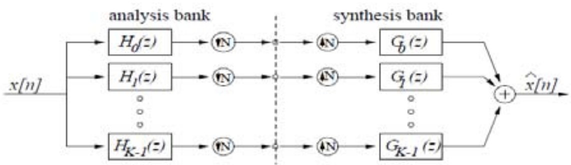


Figure 2 : Analysis and synthesis branch of an n-channel filter bank [13]

In this process the analysis bank decomposes the image I into K subbands, each produced by a branch $H_z(k)$ of the analysis bank. After decimation and expansion by a factor N, the full band signal is reconstructed from the subbands in the synthesis bank by filtering with filters $G_k(z)$ followed by summation. The analysis filters $H_k(n)$ are derived from the real value of a lowpass FIR filter p[n] of even length $L_{p.}$ For the estimation of signal using such filtration cost optimization approached is used where the subband are processed adaptively termed as subband adaptive filter (SAF) [13].The SAF operation is based on the LMS-type adaptive filter. The converged of such filter is based on the optimization of this LMS function, wherein weight functions are used to optimize the mean error. To converge the cost function faster in [15] a Normalized SAF (NSAF) is proposed. In this approach the convergence speed is increased by increasing the number of subband filters while maintaining the same level of steady-state error. However, it suffers from huge complexity when used in adapting an extremely long unknown system. To overcome this problem in [17] a dynamic selection based NSAF (DS-NSAF) scheme is proposed. This approach sorts out a subset of the subband filters contributing to convergence performance and utilizes those in updating the adaptive filter weight. This approach dynamically selects the subband filters so as to fulfill the largest decrease of the successive mean square deviations (MSDs) at every iteration. This approach reduces the computational complexity of the conventional SAF with critical sampling while maintaining its selection performance. The operational approach for the conventional DS-SAF approach [15] is as outlined.

In a SAF system the desired band d(n) that originates from an its lowering band is defined by,

$$d(n) = u(n)W^o + v(n) \qquad \dots (3)$$

where $w^0$is an unknown column vector to be identified with an adaptive filter, *v(i)* corresponds to a variance σ_v^2 for each band, and *u(n)* denotes a row input vector with length M defined as;

$$u(n) = [u(n)\, u(n-1) \;\dots\; u(n-M+1)] \qquad .. (4)$$

In the process of adaptive selection, the Normalized SAF (NSAF) [17] approach was proposed. A basic architecture for such coding is as shown in figure 3.

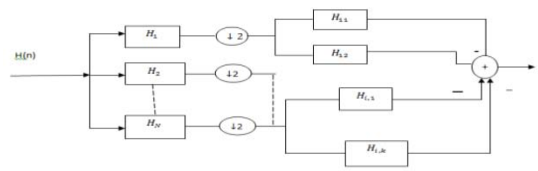


Figure 3 : NSAF filter architecture [15]

In this approach the image sample is partitioned into N subbands by the analysis filters $H_0(z)$, … $H_{n-1}(z)$. The resulting subband signals are then critically decimated to a lower sampling rate relative to their demanded bandwidth. The original signal d(n) is decimated to k signals and the decimated filter output at each subband is defined as;

$$y_{i,D}(k) = u_i(k)w(k), \qquad \dots (5)$$

Where, $u_i(k)$ is a 1 x M row such that,

$u_i(k) = [u_i(kN), u_i(kN-1), \dots\dots, u_i(kN-M+1)]$and

$w(k) = [w_0(k),\ w_1(k), \dots\dots, w_{M-1}(k)]^T$ denotes the estimated weight value and the decimated band error is then defined by,

$$e_{i,D}(k) = d_{i,D}(k) - y_{i,D}(k) = d_{i,D}(k) - u_i(k)w(k) \quad \dots (6)$$

Where $d_{i,D}(k) = d_i(kN)$ is the reference information at each band. In the process of NSAF the weight optimization is defined as,

$$w(k+1) = w(k) + \mu \sum_{i=0}^{N-1} \frac{u_i^T(k)}{\|u_i(k)\|^2} e_{i,D}(k) \qquad \dots (7)$$

Where μ is the step size.

This weight is used to optimize the band selection process where in it takes a large computation to converge for the optimization. To overcome this issue in [15] a MSD based weight optimization is proposed. In this DS-NSAF approach the largest decrease of the MSDs between successive iterations is used.

Hence the weight error vector is then defined as, $\tilde{w}(k) = w^o - w(k)$. The weight optimization is then defined as,

$$\tilde{w}(k+1) = \tilde{w}(k) - \mu \sum_{i=0}^{N-1} \frac{u_i^T(k)}{\|u_i(k)\|^2} e_{i,D}(k) \qquad \dots (8)$$

Using this weight vector and taking the expectation a MSD is computed which satisfies the absolute expectation as,

$$E\|\tilde{w}(k+1)\|^2 = E\|\tilde{w}(k)\|^2 + \mu^2 E\left[\sum_{i=0}^{N-1} \frac{e_{i,d}^2(k)}{\|u_i(k)\|^2}\right] - 2\mu E\left[\sum_{i=0}^{N-1} \frac{u_i(k)\tilde{w}(k)e_{i,D}(k)}{\|u_i(k)\|^2}\right] \qquad \dots (9)$$

$\triangleq E\|\tilde{w}(k)\|^2$

Where

$$\Delta = \mu \sum_{i=0}^{N-1}\left(2E\left[\frac{u_i(k)\tilde{w}(k)e_{i,D}(k)}{\|u_i(k)\|^2}\right] - \mu E\left[\frac{e_{i,d}^2(k)}{\|u_i(k)\|^2}\right]\right) \quad \dots (10)$$

Defines the difference of MSDs between two successive bands. With bands having minimum MSD is then chosen to have a selective band for processing rather to all decomposed bands. This band selection process reduces the processing coefficient with minimum deviation due to the selecting criterion of minimum MSD value. To this selected band then a modified encoding process is used to achieve higher level of compression as presented below.

IV. Hierarchical Encoding

In the process of encoding image coefficient for compression various approaches of image coding were proposed in past. In current system a inter band relation coding for wavelet band coefficients are used called as hierarchical coding. Various such coding approaches are well known such as EZW [14], SPHIT [18], and EBCOT [19] etc. In all these coding technique the coding takes the advantage of the nature of energy relations for subband coefficients in frequency and in space. This class of coders applies a hierarchical set partitioning process to split off significant coefficients with respect to the threshold in the current bit-plane coding pass, while maintaining areas of insignificant coefficients. In this way, a large region of zero pixels is coded into one symbol.

When an image is wavelet transformed the energy in the subbands decreases as the scale decreases, so the wavelet coefficients will, on average, be smaller in the higher subbands than in the lower subbands. In this method for every pass a threshold is chosen for which all the wavelet coefficients are measured. If a wavelet coefficient is larger than the threshold it is encoded and removed from the image, if it is smaller it is left for the next pass. When all the wavelet coefficients have been visited the threshold is lowered and the image is scanned again to add more detail to the already encoded image. This process is repeated until all the wavelet coefficients have been encoded completely or another criterion has been satisfied (such as, maximum bit rate criterion).

As an initialization step, the number of magnitude refinement passes that will be necessary is determined from the maximum magnitude of the coefficients. Initially, all pixels are treated as insignificant. The initialization is followed by three major passes – the sorting pass, the magnitude refinement pass and the quantization step update pass which are iteratively repeated in this order till the least significant refinement bits are transmitted. During the sorting pass, the pixels in the LIP, which were insignificant till the previous pass, are tested and those that become significant are moved to the LSP. Similarly, the sets in LIS are examined in order for significance and those which are found to be significant are removed from the list and partitioned. The new subsets with more than one element are added to the LIS and the single pixels are added to LIP or the LSP, depending upon their significance. During the magnitude refinement pass, the pixels in the LSP are encoded for n_{th} most significant bit. The encoding algorithm can be summarized as follows:

Step-1: initialization

Output n= $\lfloor \log_2(\max_{(n_1,n_2)}\{|c_{n_1,n_2}|\}) \rfloor$

Set the LSP=$\{\emptyset\}$

Set the LIP=$\{(n_1,n_2) \in H\}$ and LIS=$\{D(n_1,n_2),(n_1,n_2) \in H\}$

Step-2 : Sorting pass

Step-2.1 : For each entry in the LIP, output the significance ("1" if significant, "0" if not significant). If found significant, remove it from the LIP and add to the LSP.

Step-2.2 : For each entry in the LIS, output the significance. If found significant, output its sign. Perform the set partitioning using the rule-2 or rule-3, depending upon whether it is the $D(n_1,n_2)$ set or the $L(n_1,n_2)$ set. According to the significance, update the LIS, LIP and LSP.

Step-3 : Refinement pass:

For each entry in the LSP, except those which are added during the sorting pass with the same *n*, output then_{th} most significant bit.

Step-4: Quantization-step update pass

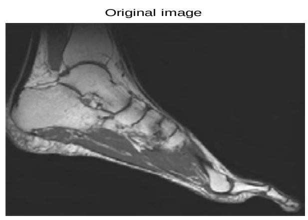
In this pass, *n* is decremented by 1 and the steps-2, 3 and 4 are repeated until $n = 0$.

The decoder steps are exactly identical. Only the output from the encoder will be replaced by the input to the decoder.

The proposed approach reduces the processing overhead by the selective approach for multiple bands generated in the process of multi wavelet transformation, and a modified encoding approach to hierarchical coding is proposed resulting in minimization of processing overhead. To evaluate the proposed approach a simulation on the developed approach is carried out, the obtained results are as explained in section 5.

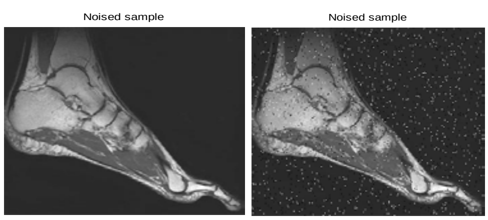
V. Result Observations

A comparative analysis is carried out for the developed approaches, wherein a qualitative measurement of the proposed approach of selective MWVLT (S-MWLT) is carried over the conventional multi wavelet coding (MWVLT) and DWT based coding. For the process of evaluation various test samples were tested and the observations obtained are as illustrated below.



Figur 4 : Original Sample

The original sample of a uniform dimension of 256 x 256 is taken. The test sample is made to a uniform dimension to provide a generality in the proposed coding. A test sample taken for evaluation is shown in figure 4.



(a) (b)

Figure 5 : Noised sample at, (a) σ=0, (b) σ=0.03

For the evaluation of the developed approaches over different noise variance the test sample is processed with salt and pepper nose with different noise variance. The effected samples at different noise variance is shown in figure.5. These samples are processed for resolution decomposition.

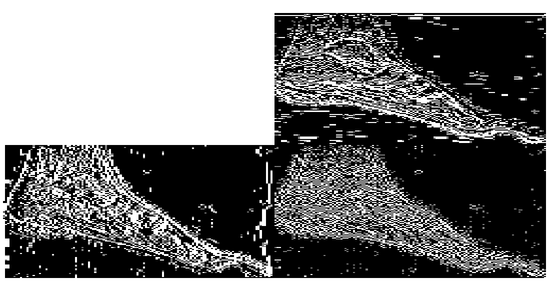
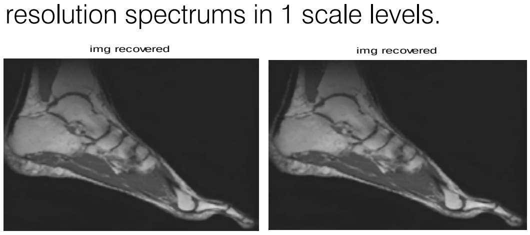


Figure 6 : DWT decomposed bands

The process of DWT based band decomposition for multi spectral coding is shown in figure.6. The original test sample is passed via hierarchical filter bank units to extract the high and low band resolution spectrums in 1 scale levels.



(a) (b)

Figure 7 : Recovered samples for DWT at, (a) σ=0, (b) σ=0.03

The recovered image samples after the DWT based coding at different noise variances is shown in figure 7 (a) and(b). The same test sample is then processed for multiwavelet coding. The observation for such coding is as illustrated.

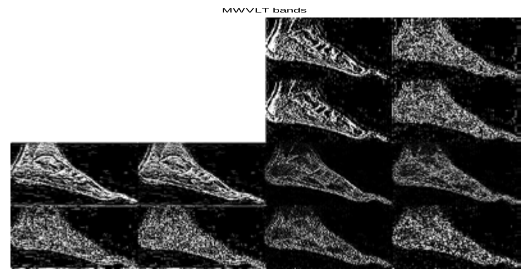
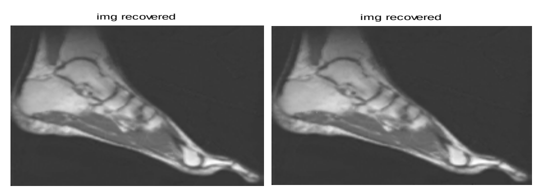


Figure 8 : Decomposed Bands using Multi-wavelet Decomposition

The decomposed bands of multi wavelet bands is shown in figure 8. The decomposition of multiple band per resolution could be clearly observed, where each resolution band is further decomposed into 4 lower sub bands.



(a) (b)

Figure 9 : Recovered samples for MWT at, (a) σ=0, (b) σ=0.03

The recovered samples based on the coding of multiwavelet decomposition is illustrated in figure 9 (a)and (b) under a noise variance of 0and 0.03 respectively. Wherein to optimize the operational performance to such coding a selective coding was proposed. The selected band for this multiband using proposed S-MWT is shown in figure 10.

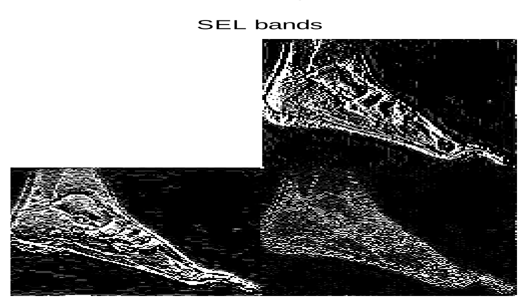


Figure 10 : Selected Bands using S-MWT

Due the optimal selection of reference bands for each spectral band based on optimal LMSE selection,

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the processing coefficient is minimized as well with the selection approach, PSNR is improved. To obtain the multi-spectral bands in S-MWT the selected are replicated. The regenerated bands for the selected band is as shown in figure 11.

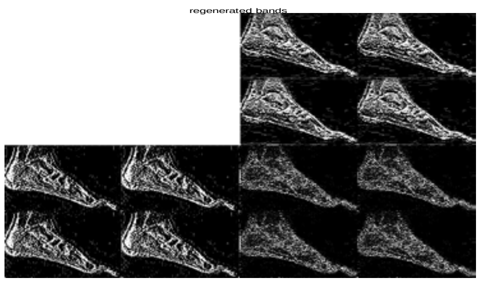
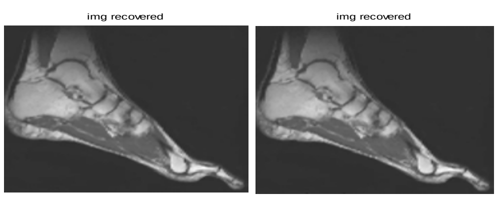


Figure 11: Regenerated bands for Multi-wavelet coding

For such selected bands the recovered samples at different noise variance is show in figure 12



(a) (b)

Figure 12 : Recovered samples for MWT at, (a) σ=0, (b) σ=0.03

To evaluate the coding performance of the developed coding system a parametric evaluation of the suggested methods is performed, the obtained observations are as illustrated below.

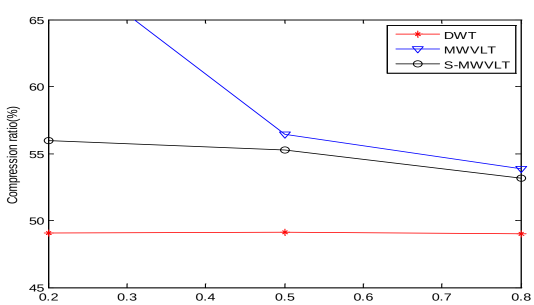


Figure 13 : Compression ratio with variation in coding rate

The compression ratio is observed to be improved in case of S-MWVLT coding with increase in coding rate. It is observed that at lower coding rate the compression is considerably high in case of MWVLT coding, as comparison to other two methods, however with increase in coding rate this factor get reduced in MWVLT and increases in S-MWVLT. This is achieved due to appropriate selection of bands, which reduces the coding coefficients, hence at higher coding rate; the number of processing bits is minimized.

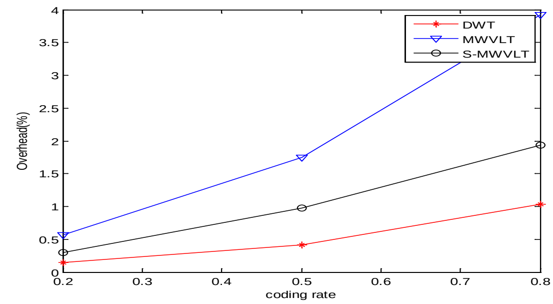


Figure 14 : Overhead with variation in coding rate

The overhead for the developed methods are observed to be increasing with increase in coding rate. This is comparatively higher in case of MWVLT coding, wherein lower in S-MWVLT coding and minimum is DWT based coding.

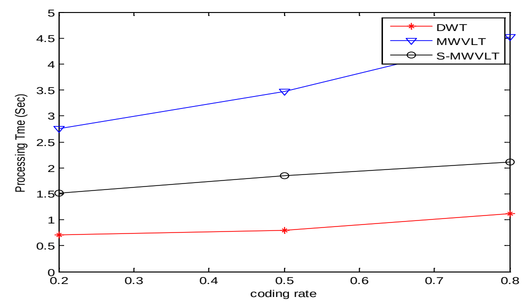


Figure 15 : Computation Time with variation in coding rate

The computation time taken for processing of these coefficients are recorded and illustrated in figure15. The processing time taken is considerably lower than MWVLT in proposed approach.

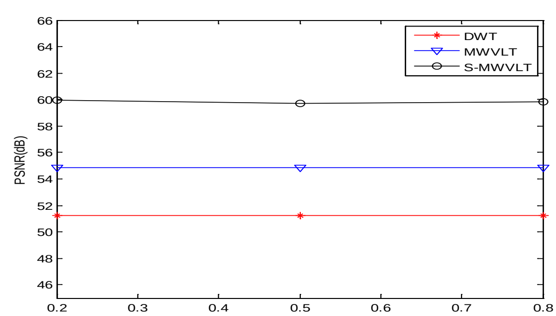


Figure 16 : PSNR with variation in coding rate

The PSNR for the developed approach is as illustrated in figure16. It is observed that, PSNR for the proposed approach of higher due to proper selection of multispectral bands and is retained about constant level at higher coding rates as well. A simulation test on various such medical samples are carried out and the obtained processing overhead and PSNR is as illustrated in table I,II respectively.

Sample	OVR @ σ = 0.1			OVR @ σ = 0.3			OVR @ σ = 0.5		
	DWT	MWT	SEL-MWT	DWT	MWT	SEL-MWT	DWT	MWT	SEL-MWT
	0.47	1.99	1.31	0.37	1.87	1.90	0.35	1.16	1.8
	0.43	1.76	1.2	0.36	1.44	1.52	0.31	1.3	1.4
	0.35	1.45	1.4	0.27	1.2	1.66	0.38	1.27	1.73
	0.44	1.3	1.36	0.3	1.55	1.22	0.364	1.8	1.44

Table I : Observation for overhead over different noise variance

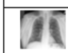
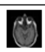
Sample	PSNR @ σ = 0.1			PSNR @ σ = 0.3			PSNR @ σ = 0.5		
	DWT	MWT	SEL-MWT	DWT	MWT	SEL-MWT	DWT	MWT	SEL-MWT
	50.31	54.21	56.89	49.22	54.21	56.89	51.26	53.4	55.2
	49.65	53.97	56.1	50.1	54.56	56.1	50.41	54.1	56.1
	50.11	54.1	56.65	50.55	54.3	56.44	50.86	53.51	56.35
	51.54	56.75	56.89	51.04	53.51	55.94	51.66	54.03	56.03

Table II : Observation for PSNR over different noise variance

VI. Conclusion

A new encoding approach for image compression is developed. The process of band selection for multi spectral information of multi wavelet coefficients is proposed. The approach of band selection process for subband coding based on normalized sub band coefficient selection procedure is adapted for band selection process. A least mean band difference for lower levels of band coefficient is proposed to achieve band selection procedure. To achieve optimal coefficient section process for hierarchal coding a pre tracing for multiple selected bands is proposed. The approach of hierarchical coding is hence optimized by a 1-dimentional tracing approach to obtain selective coefficient for performing hierarchical coding. The process of coefficient selection is achieved by the process of threshold correlation process as carried in conventional hierarchical coding. The process of encoding is then modified to encode the selected coefficients reducing the processing overhead for compression.

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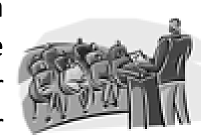

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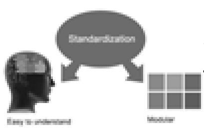

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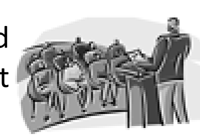

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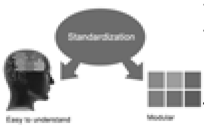

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The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

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(h) Brief Acknowledgements.

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- One should avoid outdated words.

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1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

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- Separating a table/chart or figure - impound each figure/table to a single page
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In every sections of your document

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· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

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· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

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- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

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- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- Shape the theory/purpose specifically - do not take a broad view.
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Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

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- Skip all descriptive information and surroundings - save it for the argument.
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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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