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- Review on Vessel Extraction
- Image Information Retrieval
- Image Retrieval on Macro Regions

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Image Information Retrieval based on Edge Responses, Shape and Texture Features using Datamining Techniques

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Abstract- The present paper proposes a new technique that extracts significant structural, texture and local edge features from images. The local features are extracted by a steady local edge response that can sustain the presence of noise, illumination changes. The local edge response image is converted in to a ternary pattern image based on a local threshold. The structural features are derived by extracting shapes in the form of textons. The texture features are derived by constructing grey level co-occurrence matrix (GLCM) on the derived texton image. A new variant of K-means clustering scheme is proposed for clustering of images. The proposed method is compared with various methods of image retrieval based on data mining techniques.

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Talluri. Sunil Kumar [α], T.V.Rajinikanth [σ] & B. Eswara Reddy [ρ]

Abstract- The present paper proposes a new technique that extracts significant structural, texture and local edge features from images. The local features are extracted by a steady local edge response that can sustain the presence of noise, illumination changes. The local edge response image is converted in to a ternary pattern image based on a local threshold. The structural features are derived by extracting shapes in the form of textons. The texture features are derived by constructing grey level co-occurrence matrix (GLCM) on the derived texton image. A new variant of K-means clustering scheme is proposed for clustering of images. The proposed method is compared with various methods of image retrieval based on data mining techniques. The experimental results on Wang dataset shows the efficacy of the proposed method over the other methods.

Keywords: local binary pattern, local directional pattern, textons, GLCM features.

I. Introduction

The volume of digital images produced in the world wide has increased dramatically over the past 10 decades and the World Wide Web plays a vital role in this upsurge. This has created the availability of huge digital image databases or libraries. The handling and accessing of these data base images by human annotations is impractical and it has led to the automatic search mechanisms and it has created a demand for content based image retrieval (CBIR) models. CBIR is defined as a process that searches and retrieves images from a large database. The retrieval operation is performed on the basis of derived image features such as color, texture and shape. A good literature survey was conducted on CBIR and is available in [1-4]. The color is one of the significant feature of the CBIR and one of the simple color based CBIR is the color histogram [5].The retrieval performance of this generally limited due to its low discrimination power mainly on immense data. To improve this various color descriptors are proposed in the literature using neural networks [6], DCT-domain vector quantization [7], supervised learning [8] and color edge co-occurrence histograms [9].

The natural images are visualized by their rich content of texture mosaic and color. The texture descriptors are based on grey scale variation and they can also integrate with color component of image retrieval (IR). It is very difficult to give unique definition to texture and it is one of the significant and salient features for CBIR. The texture based image retrieval is reported in the literature based on the characteristics of images in different orientations [10, 11, 12, 13, 14, 15]. Extraction of texture features on wavelets [16], wavelet transform based texture features [16] and correlagrams [17] are also proposed for efficient IR. The performance of the correlograms [17] is further improved using genetic algorithms (GA) [18]. The integrated methods that combine the color histograms with texture features [19, 20] and correlograms with rotated wavelets [21] attained a good IR rate. Recently, the research focuses on CBIR systems that is fetching the exact cluster of relevant images and reducing the elapsed time of the system. For this purpose, various data mining techniques have been developed to improve the performance of CBIR system. Clustering is one of the vital techniques of data mining for quick retrieval of information from the large data repositories. Clustering is an unsupervised process, thus the evolution of clustering algorithm is important due to the extraction of hidden patterns [22, 23]. There are many applications in the real-world with clustering like credit card, mark analysis, web data categorization, image analysis, text mining, pattern recognition, market data analysis, weather report analysis [24].Data clustering explicitly divides the data into a set of k user specified number of groups by trying to minimize intra-cluster variance and maximize inter-cluster variance in an iterative manner [25, 26]. Various methods are proposed in the literature to improve the performance of the data clusters [27, 28, 29] in various applications. K-means [30] is one of the popular and efficient clustering algorithms. Later various variations to k-means algorithm are proposed to improve the efficiency [31, 32, 33].

A content-based image retrieval method using adaptive classification and cluster-merging is proposed for image retrieval to find multiple clusters of a complex

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image query [34]. This method [34] achieves the same retrieval quality, under linear transformations, regardless of the shapes of clusters of a query. A cluster-based image retrieval system by unsupervised learning (CLUE), is proposed for improving user interaction with image retrieval systems by fully exploiting the similarity information [35]. The CLUE retrieves image clusters by applying a graph-theoretic clustering algorithm and it is dynamic in nature. The CLUE retrieves image clusters instead of a set of ordered images. The principle of unsupervised hierarchical clustering is also used in CBIR [36]. The modified fuzzy c-means (MFCM) clustering scheme introduced fuzzy weights and it reduced the time of clustering and also used for image retrieval [37, 66]. A content-based parallel image retrieval system to achieve high responding ability is proposed and it is based on cluster architectures [38]. It has several retrieval servers to supply the service of content-based image retrieval. Many researchers used k-means clustering with variations and achieved a good image retrieval rate [39, 40, 41,42]. K-means clustering technique is helpful to reduce the elapsed time of the system.

The rest of the paper organized as follows: The proposed method, local directional pattern (LDP),k-means and query matching are given in Section 2. Experimental results and discussions are summarized in section 3. Based on above work, conclusions are made in section 4.

II. Proposed Method

The present paper initially converts the color image into grey level image using HSV quantization. The present paper derives integrated features that significantly holds edge, shape and texture features, for this initially edge responses are obtained then shape features in the form of textons are evaluated. Then GLCM features are obtained. Images are clustered based on the two point perimeter K-means (TPP-KM) clustering scheme. A similarity measure in the form of Euclidian distance is used to retrieve the top most similarity images.

a) Algorithm for feature extraction

The features are extracted based on the following steps

Step 1: The color image is converted in to grey level images using HSV color space.

Step 2: Conversion of edge response image in to ternary pattern image. This is derived based on two sub steps 2(a) and 2 (b).

Step 2 a): The local features in the form of edge responses in eight directions are obtained on the grey level image based on local direction pattern (LDP) coded image.

The formation process of LDP is explained below.

The LDP is an eight bit binary code that describes the relative edge value of a pixel in different directions [43]. The present paper evaluates edge responses in eight directions on a central pixel of a 3 x 3 neighborhood using Kirsch masks [68].Out of eight (m_i/i=0, 1 ….7) only the k-most significant edges are given a value 1 and the remaining are set to zero. The three greatest responses, i.e. k=3 are considered in the present paper. The reason for this is the occurrence of corner or edge indicates a huge edge response value in a particular direction. The LDP code generation on a 3x3 neighborhood is shown below in Figure 1. The advantage of LDP over Local binary pattern (LBP) is, LDP can sustain the noise. And this is shown Figure 2. The Figure 2(b) corresponds to the noisy or fluctuated neighborhood of Figure 2(a). In this case the LBP code changes drastically whereas the LDP retains the same value.

25	28	65
35	85	75
50	48	65

Mask index	m_7	m_6	m_5	m_4	m_3	m_2	m_1	m_0
Mask value	331	131	-109	-293	-469	-229	171	467
Rank	2	4	5	7	8	6	3	1
Code bit	1	0	0	0	0	0	1	1
LDP code	131							

Figure 1: Transformation of LDP code for K=3

85	32	26
53	50	10
60	38	48

(a)

LBP=00111000
LDP=00010011

85	32	26
49	50	10
60	38	48

(b)

LBP=00101000
LDP=00010011

Figure 2: Stability of LDP vs. LBP (a) Original image (b) Image with noise

Step 2b): Conversion of LDP coded image in to ternary form, based on a threshold. This mechanism simplifies the extraction of textons that represent shape of the texture in the next step. This also makes the present process to be resistant to lighting effects, noise and other illumination changes. For this the neighborhood pixel (p_i) values of LDP coded image are compared with central pixel (P_c) using a lag limit value *'l'*. The neighborhood values are assigned one of the ternary values T_i. (Equation 1).

$$LDTP\ (T_i) = \begin{cases} 2 & P_i \geq (P_c + l) \\ 1 & |P_i - P_c| < l \\ 0 & P_i \leq (P_c - l) \end{cases} \quad (1)$$

The process of generation of this is illustrated in Figure 3 with l=3. The proposed edge responses generate a total of 0 to K*(P-1) codes and this is considered as the main disadvantage. Here k is the number of greatest edge responses considered and p is the number of neighboring pixels. This is not considered as the disadvantage in the present paper, since we are not deriving LDP coded image and we are only deriving ternary patterns out of the LDP coded image. Further it is more convenient to derive shape feature (in the next step) on local ternary patterns (0 or 1 or 2) derived from edge responses.

38	39	101	100	20
20	25	33	67	109
53	65	43	111	117
65	132	125	145	36
120	100	65	42	144

(a) (a) neighborhood values Sample (Intensity

49	146	26
44	37	7
41	100	138

(b) (b) LDP code of image (a)

2	2	0
2	1	0
2	2	2

(c) Ternary patterns on edge responses

Figure 3: Transformation of local edge responses image into ternary pattern image

Step 3: Derivation of local shape features in the form of textons on the ternary image. The method of deriving textons on ternary image is given in Figure 4. The basic unit of an image is pixels and its intensity and experiments based on this have not resulted any satisfactory results. In order to progress the performance the pattern and shape based methods are employed. A pattern and shape consists of group or set of neighboring pixels with similar intensity levels. One of such popular measure is "texton" proposed by Julesz [44]. Textons are defined as emergent patterns or blobs. These "textons" share a common property all over the image. The methods based on LBP and textons are very useful for texture analysis and classification [45, 46, 47] face recognition [48], age classification [49, 50, 51, 52], image retrieval [15] etc. Variousarray grammar models are proposed in the literature to represent patterns and shapes [53, 54]. Based on textons one can say whether texture is fine or coarse or in any other form. Textons can be derived on a 2x 2 or on a 3x3 or on any neighborhood window. The present paper utilized all texton patterns that forms only with two and four pixels on a 2×2 grid. This derives seven textons on a 2 x 2 grid. The derivation of texton image with the above 7 local shape features (textons) is shown below Figure 4.

3	1	1	2	1	3
3	2	3	2	3	1
1	2	4	2	4	2
1	3	1	3	2	1
2	2	2	1	3	2
2	2	3	1	3	1

(a)

3	1	1	2	1	3
3	2	3	2	3	1
1	2	4	2	4	2
1	3	1	3	2	1
2	2	2	1	3	2
2	2	3	1	3	1

(b)

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

(c)

Figure 4: Transformation of Texton process: a) Original image (b) Textons identification (c) Texton image

Step 4: Derivation of GLCM features. GLCM features are computed on the derived texton matrix.

The present paper evaluated four Haralick features [55] for effective image retrieval and they are listed below. The features homogeneity, energy, contrast and correlation are evaluated with an angle of 0^o, 45^o, 90^o and 135^o and the average value of this are considered as texture feature.

Homogeniety or Angular Second Moment (ASM):

$$\text{ASM} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \{P(i,j)\}^2 \quad (2)$$

ASM is a measure of homogeneity of an image. A homogeneous scene will contain only a few grey levels, giving a GLCM with only a few but relatively high values of P (i, j). Thus, the sum of squares will be high.

Energy :

$$\text{Energy} = \sum_{i,j} P(i,j)^2 \quad (3)$$

Contrast :

$$\text{Contrast} = \sum_{n=0}^{G-1} n^2 \left\{ \sum_{i=1}^{G} \sum_{j=1}^{G} P(i,j) \right\}, |i-j| = n \quad (4)$$

This measure of contrast or local intensity variation will favor contributions from P (i, j) away from the diagonal, i.e. i ! = j.

Correlation :

$$\text{Correlation} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{\{iXj\}XP(i,j) - \{\mu_x X \mu_y\}}{\sigma_x X \sigma_y} \quad (5)$$

Correlation is a measure of grey level linear dependence between the pixels at the specified positions relative to each other.

b) Clustering method

One of the commonly used and simplest algorithm for clustering is the K-means algorithm. K-means is one of the fundamental algorithms of clustering and it employs the square error criterion. The numbers of partitions are to be defined in K-means initially. The cluster centers are randomly initialized for predefined number of clusters. If the initial number of clusters is not properly chosen then the output of algorithm may converge to false cluster locations and completely different clustering result [58, 59]. This measure is often called the squared-error distortion [60, 61] and this type of clustering falls into the general category of variance-based clustering [62, 63].

The present paper outlined a new variation to the existing K-means algorithm to reduce the number of iterations and to increase the overall retrieval rate. This new variation of K-means scheme is denoted as two point perimeter – K-means (TPP-KM) clustering scheme. The present scheme selects two points instead of one point in K-means and also a perimeter is also evaluated and the similarity is evaluated by using Euclidean distance.

c) Query matching and performance measure

The present retrieval model selects 20 top images from the database images that are matching with query image. This is accomplished by measuring the distance between the query image and database images. The present paper used Euclidean distance as the distance measure and as given below

$$Dist_s(T_n, I_n) = \left(\sum_{i,j=1} |f_i(T_n) - f_j(I_n)|^2\right)^{1/2} \quad (6)$$

Where T_n query image, I_n image in database;

The database image is used as the query image in our experiments. If the retrieved image belongs to the same category as that of query image we say that the system has suitably identified the predictable image otherwise the system fail to find the image. The performance of the present model is evaluated in terms of precision, recall rate and F-Measure as given in equation 7, 8 and 9.

$$Precision\ P = \frac{Number\ of\ relevant\ images\ retrieved\ (I_{RR})}{Number\ of\ retrieved\ images\ (I_{NR})} \quad (7)$$

$$Recall\ R = \frac{Number\ of\ relevant\ images\ retrieved\ (I_{RR})}{Total\ number\ of\ relevant\ images\ in\ the\ database\ (I_{TR})} \quad (8)$$

The algorithms that improve precession may degrade recall and vice versa. The present paper also evaluates another parameter called F-measure that is based on both precession and recall.

$$F - Measure = \frac{2*(precision * recall)}{(precision + recall)} \quad (9)$$

III. Results and Discussion

In order to efficiently investigate the performance of the present retrieval model, we have considered the Wang database [64]. Wang is a subset of Corel stock photo database of 1000 images. These images are grouped into 10 classes, each class contains 100 images. Within this database, it is known whether any two images are of the same class. Classification of the images in the database into 10 classes makes the evaluation of the system easy. The hefty size of each class and the heterogeneous image class contents made Wang data base as one of the popular database for image retrieval. The present paper considered 7-classes of images and 100 images per each class. For a query image the relevant images are assumed to be the remaining 99 images of the same class. The images from all other classes are treated as irrelevant images. The retrieval performance of the proposed method is judged in terms of precession, recall and F-measure. The proposed clustering method derived integrated novel features from edge responses, shapes in the form of textons and statistical parameters in the form of texture features (GLCM features). The average retrieval performance of the proposed method is compared with CBIR methods using data mining techniques [65, 66, 67] and the proposed method with K-means clustering method. The proposed method outperformed all the other methods in terms of precession, recall and F-measure and this is shown in the Figure 5, 6 and Figure 7. In the method [65] the features are extracted by GLCM features. In the existing method [67] fuzzy C-means clustering scheme is used with GLCM features and the method [66] used both color and statistical features with portioned clustering scheme. The advantage of the proposed method is the derivation of significant and powerful local features. Figure 8 shows seven examples of retrieval images, i.e. one image from each class, by the proposed method with 20-top most retrieved image.

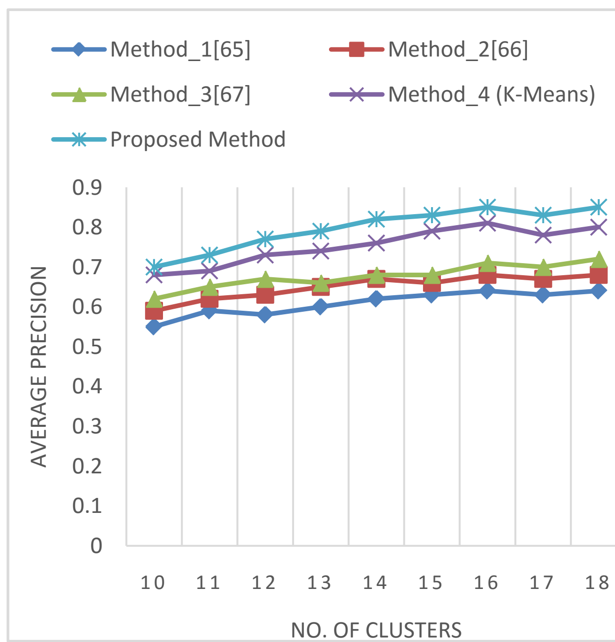

Figure 5: Average precision graph

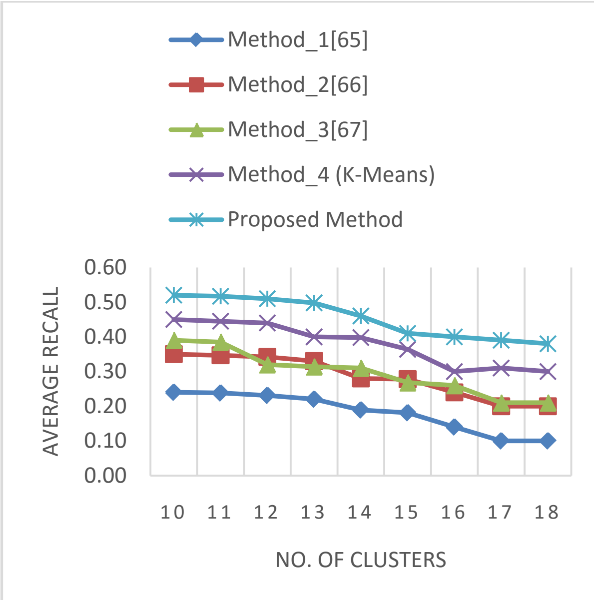

Figure 6: Average recall graph

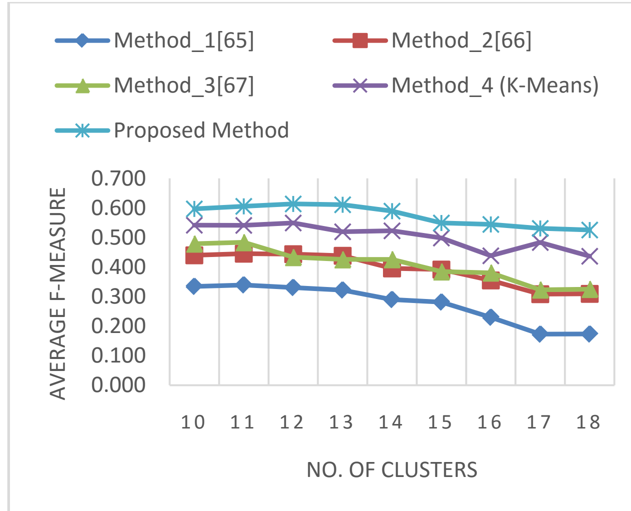

Figure 7: Average F-Measure graph

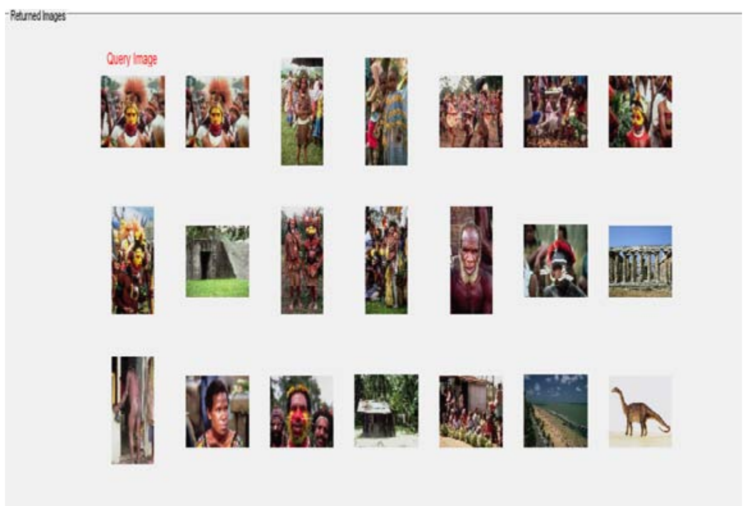

Figure 8(a): Retrieved African images

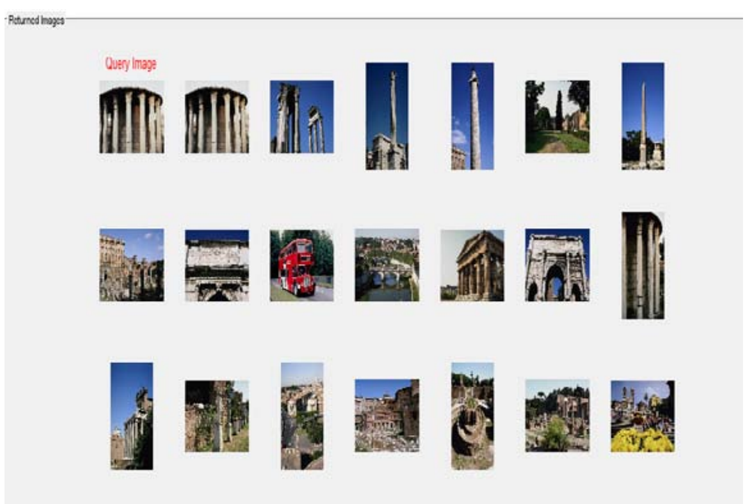

Figure 8(b): Retrieved monuments

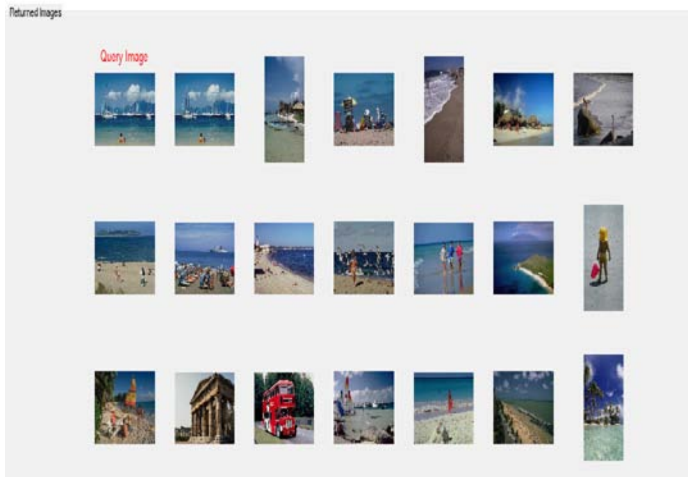

Figure 8(c): Retrieved beach sand images

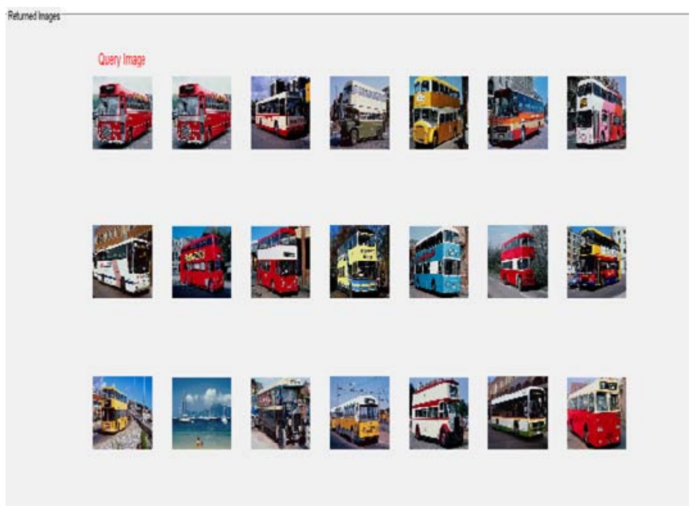

Figure 8 (d): Retrieved busses

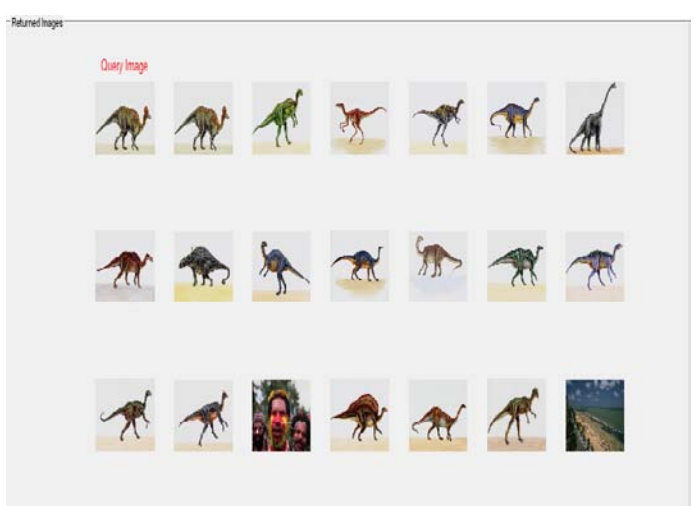

Figure 8(e): Retrieved dinosaurs

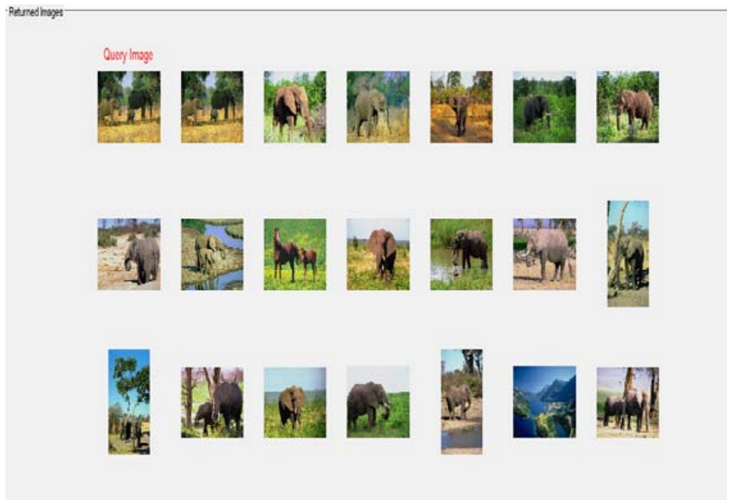

Figure 8 (f) : Retrieved elephant's images

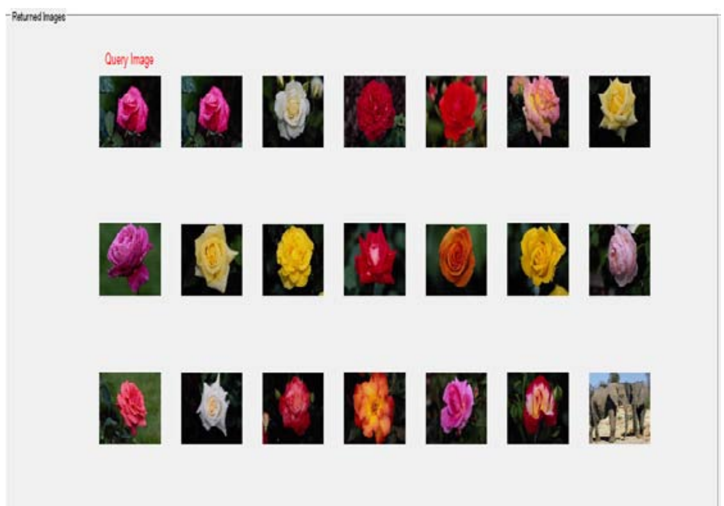

Figure 8(g): Retrieved flower images

IV. Conclusions

The present paper proposed a CBIR method using a data mining algorithm. The proposed method used a simple clustering scheme and achieved high retrieval rate when compared with the other existing methods because the proposed method extracted powerful and significant local features derived from edge responses, shape and textural properties. As with many other clustering algorithms, a limitation with our algorithm is that it requires the number of clusters to be known in prior. The advantage of edge responses is it can sustain with non-monotonic illumination variation and random noise. The shape features derived from textons are rotationally invariant. The texture features in the form of GLCM features with the help of clustering scheme retrieved the images in an accurate manner. The proposed method is experimented with one of the popular and heterogeneous dataset "Wang" and the experimental results indicates the superiority of the present method over the other existing methods.

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An Optimal Factor Analysis Approach to Improve the Wavelet-based Image Resolution Enhancement Techniques

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Abstract- The existing wavelet-based image resolution enhancement techniques have many assumptions, such as limitation of the way to generate low-resolution images and the selection of wavelet functions, which limits their applications in different fields. This paper initially identifies the factors that effectively affect the performance of these techniques and quantitatively evaluates the impact of the existing assumptions. An approach called Optimal Factor Analysis employing the genetic algorithm is then introduced to increase the applicability and fidelity of the existing methods. Moreover, a new Figure of Merit is proposed to assist the selection of parameters and better measure the overall performance.

Keywords: *super-resolution; interpolation; discrete wavelet transform (DWT)*

GJCST-F Classification: *I.3.3, I.4, B.4.2, H.2.8*

ANOPTIMALFACTORANALYSISAPPROACHTOIMPROVETHEWAVELETBASEDIMAGERESOLUTIONENHANCEMENTTECHNIQUES

An Optimal Factor Analysis Approach to Improve the Wavelet-based Image Resolution Enhancement Techniques

Wasnaa Witwit [α], Yitian Zhao [σ], Karl Jenkins [ρ] & Yifan Zhao [Ѡ]

Abstract - The existing wavelet-based image resolution enhancement techniques have many assumptions, such as limitation of the way to generate low-resolution images and the selection of wavelet functions, which limits their applications in different fields. This paper initially identifies the factors that effectively affect the performance of these techniques and quantitatively evaluates the impact of the existing assumptions. An approach called Optimal Factor Analysis employing the genetic algorithm is then introduced to increase the applicability and fidelity of the existing methods. Moreover, a new Figure of Merit is proposed to assist the selection of parameters and better measure the overall performance. The experimental results show that the proposed approach improves the performance of the selected image resolution enhancement methods and has potential to be extended to other methods.

Keywords: super-resolution; interpolation; discrete wavelet transform (DWT).

I. Introduction

Resolution has been always an important property in images and videos. High resolution (HR) image/video has a desired and strong demand in most imaging applications as it contains more details that can be crucial in these applications [1]. Resolution enhancement based on a single low-resolution (LR) image or multiple LR images has been used for different applications in various fields, such as satellite imaging [2]–[5], medical imaging [6], [7], and video enhancement [8]–[10].

Interpolation is one of the most commonly used techniques for increasing the resolution of a digital image [11]–[13]. There are four well-known interpolation methods, namely, nearest neighbor, bilinear, bicubic, and Lanczos. Nearest neighbor interpolation is the simplest method where the intensity of the new location point is assigned as that of the old location point which is the nearest neighbor to the new point. Although it is simple to implement, it produces undesirable artefacts, such as distortion of straight edges. In the bilinear interpolation, the value of a new pixel is interpolated linearly using the four nearest neighbour pixels by taking a weighted average of these pixels [14]. Bicubic interpolation preserves fine details better and is more complex than bilinear interpolation where sixteen nearest neighbour pixels are used to estimate the value of the new pixel by taking a weighted average of these points. This method is more efficient and accurate and has become the most popular image interpolation method [15]. Lanczos interpolation increases the capability to detect linear features [16]. However, the main drawback of most interpolation-based methods is that the produced images suffer from blurring and staircase artefacts.

Resolution enhancement techniques in the wavelet domain have attracted more and more investigations to address the problems associated with conventional interpolation methods. Wavelet-Zero Padding (WZP) is relatively simple to implement and is capable of outperforming the conventional interpolation methods but it commonly introduces artefacts such as smoothing and ringing in the neighbourhood of edges in the reconstructed HR image. Addressing this problem, a Cycle-Spinning (CS) based WZP method was proposed [17]. Hidden Markov Tree (HMT) based resolution enhancement method is capable of modelling the statistical relationships between coefficients at different scales [18], but the main drawback is that the used Gaussian model does not take into account to keep track of the sign coefficients since the Gaussian is symmetrical around zero and the signs of these coefficients are randomly generated. To reduce this shortcoming, a refined HMT based method was proposed in [19], where the magnitude parameters are estimated using the HMT model, and the sign parameters are estimated based on a higher correlation among the parameters between a high-pass filtered version of the LR image and the high-frequency sub-bands. A Directional Cycle-Spinning (DCS) method was introduced in [20], where approximates of edge orientation information are derived from a wavelet decomposition of the LR image and used to affect the choice of CS parameters. It can refine better edge orientation and prevent staircase artefacts. More recently, a new dual-tree complex wavelet transform (DT-CWT) technique [4] based on non-local-means (NLM) filter and Lanczos interpolation was proposed for resolution enhancement of satellite images. In this

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method, the high-frequency coefficients produced by CWT and the input image are interpolated using the Lanczos interpolation. A Demirel-Anbarjafari Super Resolution (DASR) method [21] was proposed based on Discrete Wavelet Transform (DWT), where three high-frequency components produced by DWT as well as the input image are interpolated using the bicubic interpolation. An updated DASR technique was proposed in [2] with its application in satellite images. Although DWT has been used to preserve the high-frequency details of the image, but downsampling in each of the DWT sub-bands and then the interpolation of the high-frequency sub-bands generate information loss in each of these sub-bands. More recently, a technique based on DWT and stationary wavelet transform (SWT) [22] was proposed to correct the estimated high-frequency sub-bands produced using DWT by adding the high-frequency sub-bands obtained by using SWT.

A major limitation of most above methods is that the assumptions they make are not always satisfied for real applications. For example, the detail of a physical object that an optical instrument can reproduce in an image has limits that are mandated by laws of physics, whether formulated by the diffraction equations in the wave theory of light or the Uncertainty Principle for photons in quantum mechanics. There is no such a well-accepted model can fully describe the underlying mechanism. This mechanism can also be various case by case. In other words, the superior of one method than other methods claimed in the literatures is conditional. Although it has been reported that the performance of resolution enhancement methods can be affected by the methods to produce the low-resolution image, and other factors [16], there is very limited literatures investigating how to utilise these factors to assess and improve the resolution enhancement performance. Addressing this problem, this paper proposes an Optimal Factor Analysis method to increase the applicability and fidelity of the existing methods.

Although the authors are aware that machine-learning-based super-resolution methods have attracted more and more interests recently [23]–[28], this paper focuses on wavelet-based methods and interpolation methods only. Section 2 initially identifies the important factors that affect the performance and analyses corresponding importance, and then proposes the new method as well as a new Figure of Merit to assist the selection of parameters. Section 3 presents the results of quantitative analysis using the proposed method and associated discussions. Conclusions are presented in the final section.

II. Method

a) *Important Factors*

Table 1 summarises the reviewed wavelet-based image resolution enhancement techniques in terms of the way to evaluate their performance. The inconsistency of assumption of the considered factors for each individual technique has been observed. For example, the considered methods make the assumption that the observed LR image is produced by either applying a low-pass filtering and then downsampling, or achieving the low-frequency (LL) sub-band of DWT. For some methods, the description of these factors is either neglected or unclear. The performance of these methods is unknown when such an assumption is not satisfied. A method to compare the resolution enhancement methods in a more comprehensive

Table 1: Summary of different wavelet-based resolution enhancement techniques in terms of performance assessment

Techniques	Input LR Image	Scale Factor	Interpolation Method	Wavelet Function	Test Image
WZP-CS [17]	LL sub-band of DWT	2 & 4	N/A	Db.9/7	Lena, Elaine, Baboon, and Peppers
WZP-DCS [20]	Low-pass filtering and downsampling	2 & 4	N/A	Db.9/7	Lena, Elaine, Baboon, and Peppers
HMT [18]	Downsampling of HR image	N/A	N/A	N/A	Lena
HMT [5]	Downsampling of HR image	2	N/A	N/A	Lena
HMT [19]	low-pass filtering and downsampling	2 & 4	N/A	Db.9/7	Lena, Elaine, Baboon, and Peppers
CWT [3]	LL sub-band of DWT	2 & 4	Bicubic	N/A	5 Satellite Images

DT-CWT [4]	Downsampling of HR image	4	Lanczoc	N/A	1 Satellite Image (Washington DC)
DASR [21]	LL sub-band of DWT	4	Bicubic	Db.9/7	Lena, Elaine, Baboon, and Peppers
DWT-Difference [2]		4	Bicubic	Db.9/7	5 Satellite Images
DWT-SWT [22]		4	Bicubic	Db.9/7	Lena, Elaine, Baboon, and Peppers
DWT-SWT [6]		4	Bicubic	N/A	Lena, Elaine, Head, and Brain

and equitable way is required. Such a method can also be used to further improve the overall performance of existing methods.

Each potential factor that affects the performance has been studied one by one. In order to quantitatively evaluate the performance, the widely used Peak-signal-to-noise-ratio (PSNR) has been employed in this paper, and it can be calculated by

$$PSNR = 10\log_{10}\left(\frac{L^2}{MSE}\right) \quad (1)$$

where L denotes the maximum fluctuation in the input image. Mean Square Error (MSE) measures the error between the super resolved image ISR and the original HR image $Iorg$. It can be calculated by

$$MSE = \frac{\sum_{i,j}(I_{SR}(i,j)-I_{org}(i,j))^2}{M\times N} \quad (2)$$

where M,N denote the width and height of the HR image respectively.

i. *The mechanism to produce low-resolution images*

It has been identified from the literature review that there are various ways to generate LR image including (a) downsampling of the original HR image through DWT, (b) bicubic interpolation, (c) bilinear interpolation, (d) nearest neighbour, and (e) low-pass filtering. Table 2 shows the resulting PSNR values for the Lena image using different resolution enhancement methods by considering different LR image generation methods. Inspection of Table 2 shows that WZP with the wavelet function db.9/7 has the best performance among the considered

Table 2: PSNR results for Lena image using different techniques for resolution enhancement from 128×128 to 512×512 for several LR image generation methods

Techniques	PSNR (dB)					
	DWT by DB.9/7	DWT by Haar	Bicubic	Bilinear	Nearest	Low-pass
WZP(haar)	22.36	25.77	25.75	25.19	24.35	25.18
WZP(db.9/7)	**24.22**	25.75	25.73	25.23	23.21	24.04
Bicubic	22.51	**26.31**	**26.28**	**25.75**	24.80	**25.67**
Bilinear	22.63	25.53	25.54	24.85	**24.87**	25.21
Nearest	21.53	24.71	24.61	24.44	22.79	23.97

methods for the input image produced by DWT with the wavelet function db.9/7. For the LR images obtained by DWT (Haar), bicubic, bilinear interpolations and low-pass filtering methods, the bicubic interpolation method has the best performance, but for the LR images produced by the nearest neighbor, the bilinear interpolation technique has the best performance. These observations clearly indicate that the method to produce LR images has significant effect on the performance of different techniques.

ii. *Wavelet Function*

There are several well-known wavelet families such as Daubechies (db) (db.1 is also referred as Haar), Symlets (sym), Biorthogonal (bior), Coiflets (coif) etc [29]. In this paper, the behaviour of the considered resolution enhancement techniques has been studied for a wide range of wavelet families as well as their various parameters, including db.1-20, sym.2-20, bior.1-6 and coif.1-5. Note that db.9/7 is equivalent to bior4.4 [30]. Table 3 shows the PSNR values for three test images (Lena, Baboon, and Elaine) using the WZP method with various wavelet functions, where only the parameters producing high PSNR values are shown to save space. The input LR image was produced by downsampling using DWT with db.9/7 wavelet function as suggested in [21]. The quantitative results show that coif2, sym3, and db3 are top three wavelet functions in terms of PSNR values, not the well investigated Haar or bior4.4. This observation is consistent for all three test images. This observation indicates that the selection of wavelet function can play a key role in improving performance. However, in most of existing wavelet-based methods, very few of them has discussed the selection of wavelet function.

iii. *Enlargement Factor*

As shown in Table 1, the performance of most methods are evaluated by a scale factor of 2 or 4. To better evaluate the effectiveness of this factor on performance, this paper considered a wide range of scale of 2, 4, 8 and 16. The input LR image has been obtained by downsampling using DWT with db.9/7 wavelet function. The produced PSNR values for Lena image are shown in Table 4, inspection of which shows that the WZP method with db.9/7 produces the highest PSNR values for all enlargement factors. Lanczos and bicubic techniques provide higher PSNR values than bilinear technique for the scale of 2 but for the scale of 4 and 8 the bilinear technique produces higher PSNR values. The variation on performance of the

Table 3: PSNR results for three well-known test images (Lena, Baboon, and Elaine) generated using DWT with db.9/7 using different techniques for resolution enhancement from 128×128 to 512×512 of various wavelet families and parameters

Techniques	PSNR (dB)		
	Lena	Baboon	Elaine
Bicubic	22.51	24.21	25.49
Bilinear	22.63	24.23	25.52
Nerest	21.53	23.49	24.40
WZP (haar)	22.36	24.09	25.31
WZP (bior 1.1)	22.36	24.09	25.31
WZP (bior 2.2)	24.19	25.19	27.40
WZP (bior 3.1)	22.64	24.27	25.57
WZP (bior 4.4)	24.22	25.23	27.46
WZP (bior 5.5)	24.13	25.19	27.41
WZP (bior 6.8)	24.22	25.22	27.44
WZP (sym2)	25.32	25.67	28.77
WZP (sym3)	**26.45**	**26.26**	**30.15**
WZP(sym7)	25.59	25.91	28.90
WZP (sym15)	25.56	25.88	29.08
WZP (sym19)	26.15	26.13	29.86
WZP (coif1)	24.16	25.18	27.39
WZP (coif2)	**26.56**	**26.30**	**30.28**
WZP (coif3)	24.08	25.16	27.41
WZP (db2)	25.32	25.76	28.77
WZP (db3)	**26.45**	**26.26**	**30.15**
WZP (db4)	24.21	25.23	27.51

Table 4: PSNR results for Lena image generated using DWT with db.9/7 for enlargement factors of 2, 4, 8 and 16 using different techniques

Techniques		PSNR (dB)		
	Factor 2	Factor 4	Factor	Factor 16
WZP(db.9/7)	**32.93**	**24.22**	**19.89**	**17.22**
WZP(haar)	26.44	22.36	19.26	16.97
Bicubic	28.05	22.51	19.28	16.98
Lanczos	28.06	22.39	19.16	16.83
Bilinear	27.77	22.63	19.46	17.22
Nearest	26.44	21.53	18.60	16.32

considered methods decreases following the increase of scale factor, which indicates that the scale factor is an important factor to be considered for performance assessment.

iv. *Interpolation Function*

Because of the obvious weakness, in this paper, the nearest method has been neglected, and bilinear, bicubic and Lanczos have been tested. The input LR image has been produced by downsampling using DWT with db.9/7 wavelet function. The PSNR results for Lena image are shown in Table 5, inspection of which indicates that there is no significant difference in performance for different interpolation methods. Moreover, the interpolation method producing the highest PSNR is not consistent for different methods. These observations indicate that the selection of interpolation function for wavelet-based techniques can affect the performance, but not significantly.

b) *Optimal Factor Analysis*

The behaviour of resolution enhancement methods has been assessed above by varying one factor and fixing other factors, which aims to identify the important factors but it cannot reveal the best technique with the optimal parameter selection[1]. Addressing this challenge, this paper proposes an Optimal Factors Analysis (OFA) approach in order to increase the performance of the existing methods, and also better assess their overall performance.

OFA considers a resolution enhancement technique, Ø, as a Multi-Input and Multi-Output (MIMO) model, which includes 5 inputs variables: the way to produce LR image $LR_a(a=1,2,\ldots,A)$, the scale factor $SF_b(b=1,2,\ldots,B)$, the testing image $TI_c(c=1,2,..,CW)$, the

Table 5: PSNR results for Lena image generated using DWT with db.9/7 for resolution enlargement factor from 128×128 to 512×512 using different techniques

Techniques		PSNR (dB)	
	Bicubic	Lanczos	Bilinear
WZP+CS(db.9/7)	**24.23**	24.18	24.05
WZP(db.9/7)	**24.22**	24.18	24.05
WZP(haar)	22.36	22.23	**22.52**
WZP(coif2)	26.56	**26.88**	25.60

wavelet function $WF_d(d=1,2,\ldots,D)$, and the interpolation method $IM_e(e=1,2,\ldots,E)$, where A,B,C,D, and E are the total number of possible states for 5 variables respectively. There are three outputs including the highest $PSNR$ value $PSNR*$, the optimal wavelet function WF^* and the optimal interpolation method IM^*. The MIMO model can therefore be written as:

$$(PSNR*,WF*,IM*)=F_{\emptyset}(LR_a,SF_b,TI_c,WF_d,IM_e) \quad (3)$$

Depending on the value of A,B,C,D, and E, Eq. (3) can be solved by either an exhausted search or advanced optimisation techniques. In this paper the Genetic Algorithm was employed.

To better compare the overall performance, this paper introduces a new Figure of Merit (FoM), called Ratio of PSNR (RPSNR) that considers the 'bicubic' interpolation as the baseline. For a testing image TI_c, a way to produce LR images LR_a, and a scale factor SF_b, RPSNR of the technique Ø can be written as

$$RPSNR_{\emptyset}(LR_a, SF_b, TI_c) = \frac{\max PSNR_{\emptyset}(LR_a,SF_b,TI_c,WF_d,IM_e)}{PSNR_{\emptyset}(LR_a,SF_b,TI_c,'bicubic')} \quad (4)$$

A higher $RPSNR$ indicates a better performance. To collectively assess the performance of $\emptyset$ over all considered factors, the averaged RPSNR is introduced and expressed as

$$\overline{RPSNR}_{\emptyset} = \frac{1}{A\times B\times C}\sum_{a=1}^{A}\sum_{b=1}^{B}\sum_{c=1}^{C} RPSNR_{\emptyset}(LR_a, SF_b, TI_c) \quad (5)$$

c) Results and Discussions

This study considered Six methods to generate input LR images (A=6), including DWT with db. 9/7 wavelet function, DWT with Haar wavelet function, bicubic, bilinear, nearest, and low-pass filtering. Three scale factors 2, 4, and 8 (B=3) and Three testing (C=3) including Lena, Baboon, and Elaine were tested. Considered wavelet functions include Daubechies (db.1 to db.20), Symlets (sym.2 to sym.20), Coiflets (coif.1 to coif.5) and Biorthogonal (bior1.1 to bior6.8). Considered resolution enhancement techniques can be classified into five groups: interpolation methods and four WZP based methods with different wavelet families (WZP+db,

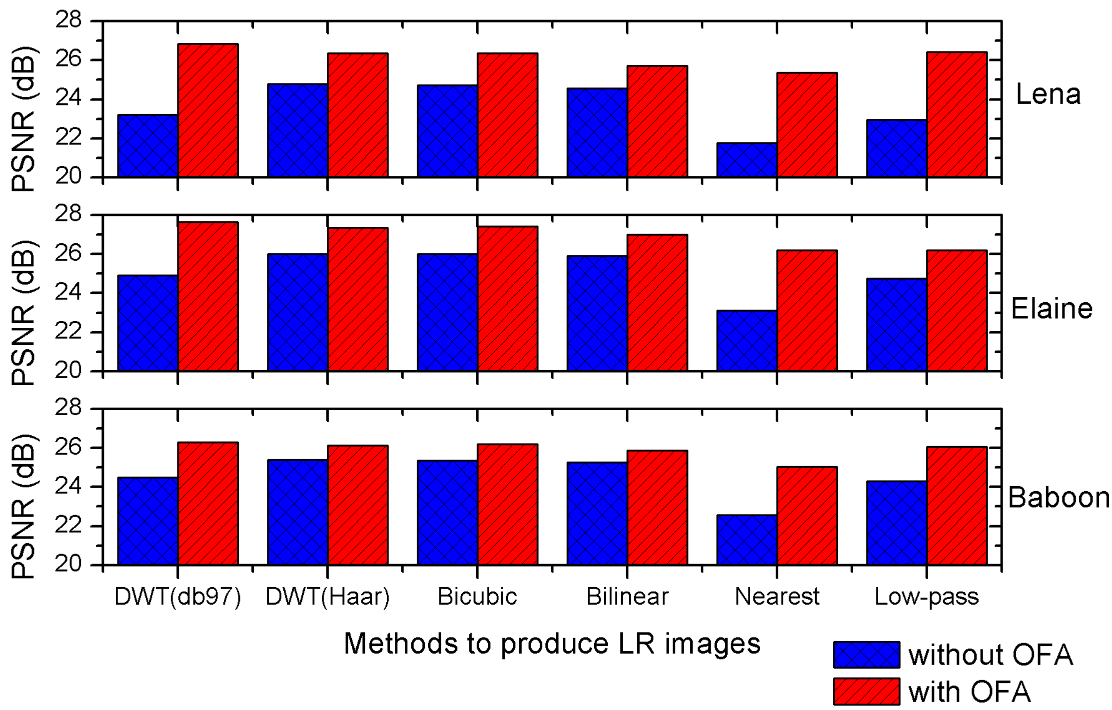

Figure 1: Performance improvement for the WZP technique by applying the proposed OFA method for the scale factor of 4

WZP+sym, WZP+coif, and WZP+bior). Three interpolation methods (E=3) were considered, namely bilinear, bicubic and Lanczos.

Fig. 1 illustrates the performance of the WZP method before and after applying the proposed method, where the LR images were super-resolved from 128×128 to 512×512. The blue and red bars plot the PSNR values before and after applying OFA respectively. It is clearly shown that the proposed method significantly improves the performance for all 7 ways to produce LR image and all three tested images.

Table 6 shows the results including the best-performed method with its parameter selection, as well as the highest PSNR and RPSNR value for different factors. For the LR image obtained from DWT with db. 9/7 wavelet function, the optimal class corresponding with the optimal interpolation method is WZP using "sym" with bilinear interpolation for the Lena image with scale factor 2. However, for the Baboon and the Elaine images, the best class is WZP using "bior" with bilinear interpolation. For scale factor 4 and 8, the best class with the best interpolation method is WZP using "coif" with Lanczos interpolation for all three images. For

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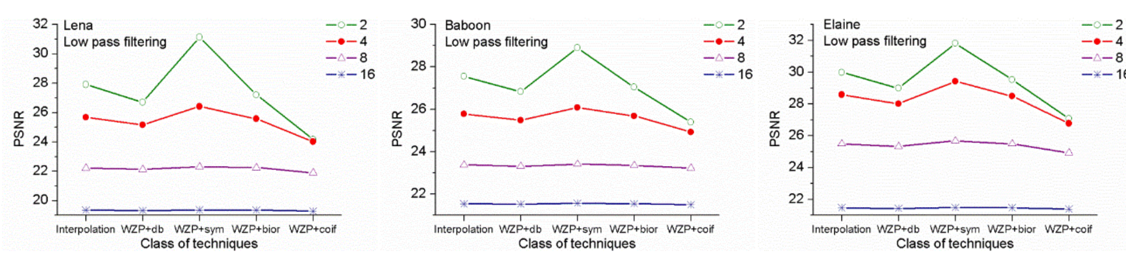
Table 6: Highest PSNR results and RPSNR corresponding with optimal super resolution techniques and interpolation method for Lena, Baboon and Elaine images with three scale factors 2, 4, and 8

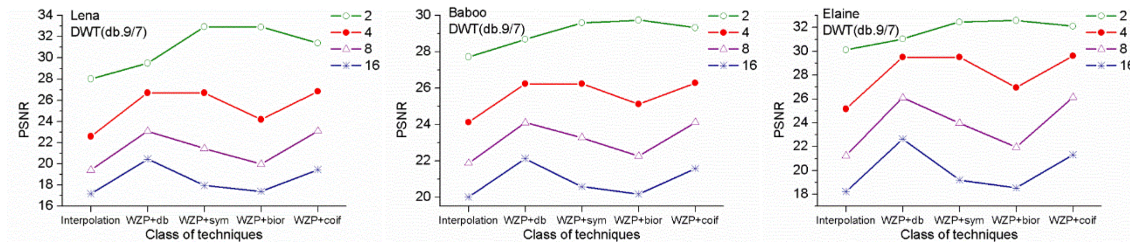
Testing image	Scale factor	Methods to produce LR image					
		DWT by DB.9/7	DWT by Haar	Bicubic	Bilinear	Nearest	Low-pass
Lena	2	WZP(sym20) Bilinear 32.98(1.1762)	Interpolation Lanczos 32.63(1.0221)	Interpolation Lanczos 32.48(1.0237)	Interpolation Lanczos 30.85(1.0218)	WZP(sym18) Bilinear 31.22(1.1321)	WZP(sym18) Bilinear 31.18(1.1233)
	4	WZP(coif2) Lanczos 26.88(1.1945)	Interpolation Lanczos 26.56(1.0097)	Interpolation Lanczos 26.58(1.0117)	Interpolation Lanczos 25.89(1.0126)	WZP(sym18) Bicubic 25.40(1.0244)	WZP(sym18) Lanczos 26.45(1.0305)
	8	WZP(coif4) Lanczos 23.14(1.2008)	Interpolation Lanczos 23.05(1.0058)	Interpolation Lanczos 23.09(1.0078)	Interpolation Lanczos 22.64(1.0096)	WZP(sym8) Bilinear 21.76(1.0051)	WZP(sym9) Bicubic 22.35(1.0035)
Baboon	2	WZP(bior4.4) Bilinear 30.09(1.0733)	Interpolation Lanczos 29.65(1.0035)	Interpolation Lanczos 29.68(1.0088)	WZP(sym13) Bilinear 28.98(1.0100)	WZP(sym6) Bilinear 28.09(1.0375)	WZP(sym18) Bilinear 29.21(1.0546)
	4	WZP(coif2) Lanczos 26.44(1.0903)	Interpolation Lanczos 26.34(1.0028)	Interpolation Lanczos 26.40(1.0052)	Interpolation Lanczos 26.04(1.0063)	WZP(sym18) Bilinear 25.25(1.0257)	WZP(sym18) Bicubic 26.22(1.0119)
	8	WZP(coif4) Lanczos 24.22(1.1063)	Interpolation Lanczos 24.06(1.0030)	Interpolation Lanczos 24.10(1.0050)	WZP(bior5.5) Lanczos 23.86(1.0066)	WZP(bior3.1) Bilinear 22.76(1.0219)	WZP(sym6) Bilinear 23.49(1.0038)
Elaine	2	WZP(bior4.4) Bilinear 34.96(1.0824)	Interpolation Lanczos 34.54 (1.0043)	Interpolation Lanczos 34.56(1.0073)	Interpolation Lanczos 33.56(1.0084)	WZP(sym6) Bilinear 32.71(1.0402)	WZP(sym18) Lanczos 33.73(1.0652)
	4	WZP(coif2) Lanczos 30.64(1.1785)	Interpolation Lanczos 30.42 (1.0090)	Interpolation Lanczos 30.49(1.0096)	Interpolation Lanczos 29.70(1.0111)	WZP(sym18) Bicubic 29.35(1.0259)	WZP(sym18) Lanczos 30.39(1.0323)
	8	WZP(coif4) Lanczos 26.58(1.2371)	Interpolation Lanczos 26.60 (1.0121)	Interpolation Lanczos 26.63(1.0124)	Interpolation Lanczos 25.89(1.0139)	WZP(sym17) Bicubic 25.26(1.0069)	WZP(sym17) Bicubic 26.08(1.0073)

the LR image obtained from DWT with Haar, bicubic, and bilinear, the best technique with the highest PSNR value is Lanczos interpolation for most of the cases. For the LR image produced by nearest and low-pass filtering, the best class is WZP using "sym" for almost all cases. These observations conclude that, for the LR image obtained from DWT with db. 9/7 wavelet function, nearest and low-pass filtering, the wavelet-based techniques have the biggest potential to outperform the conventional interpolation methods, due the fact that they have relatively large RPSNR values. For the LR image obtained from Haar, bicubic, and bilinear, the wavelet-based methods have no significant advantages over the interpolation methods. This justifies that for almost all papers about wavelet-based techniques, the LR image was produced by either DWT with db. 9/7 wavelet function or low-pass filtering.

In order to show the sensitivity for the selection of class of technique with different scale factors, input LR image producing methods and test images, the highest PSNR value for each



(a) (b) (c)



(d) (e) (f)

Figure 2: Highest PSNR values for each class of super resolution technique for different test images and low resolution image producing ways. (a) Lena + low pass filtering; (b) Baboon + low pass filtering; (c) Elaine + low pass filtering; (d) Lena + DWT with db. 9/7; (e) Baboon + DWT with db. 9/7; Elaine + DWT with db. 9/7

class of technique has been detected and the results are shown in Fig. 2. The standard deviation (std) for each scale factor has been calculated to describe the performance variation of each class. Table 7 shows the std values for the three test images generated by low-pass filtering and DWT with db.9/7 respectively for scale factors 2, 4, 8 and 16. A high std value indicates that the selection of class is important because the performance for different classes of techniques is significantly varied. A low std value indicates that the performance for each class of technique is relatively similar. Fig. 2 (a), (b) and (c) illustrate the sensitivity of the class

Table 7: Standard deviation results for three test images (Lena, Baboon, and Elaine) obtained by low-pass filtering and DWT with db. 9/7 for scale factors 2, 4, 8, and 16

Scale Factor	Lena		Baboon		Elaine	
	Low-pass	DWT by db. 9/7	Low-pass	DWT by db. 9/7	Low-pass	DWT by db. 9/7
2	2.50	2.16	1.27	0.83	1.71	1.05
4	0.88	1.92	0.43	0.99	0.97	2.01
8	0.16	1.70	0.07	1.03	0.28	2.27
16	0.03	1.40	0.03	0.92	0.04	1.91

selection for Lena, Baboon, and Elaine respectively with the LR image obtained by low-pass filtering. It is observed that if the scale factor is high, the PSNR is low as expected, and importantly the std is low. This observation means that different classes of techniques have similar performance for a larger scale factor and, as a result, the selection of class of techniques is less important. On the contrast, the selection of class of technique is very important if the scale factor is low. To demonstrate the superiority of the technique comparing with others, if the low-resolution image is generated by low-pass filtering, a small scale factor is recommended.

However, for the LR images obtained by DWT with db. 9/7, the result of sensitivity analysis is different, as illustrated in Fig. 2 (d), (e) and (f). The values of std show that the selection of class of technique has significant effect on the results, and it is almost independent on the scale factor. In other words, the selection of scale factor to demonstrate the superior of a new technique is not important. Another observation is that the above conclusions are almost independent on test images due to the fact that Fig.2 (a), (b) and (c) have similar patterns, as well as Fig.2 (d), (e) and (f).

III. Conclusions

The wavelet-based image resolution enhancement techniques have been reviewed in this paper, especially the way to assess the performance. The inconsistency of assumptions has been observed, and for some methods, the description of these assumptions is either neglected or unclear. Due to the fact that the laws of physics to generate LR images are unclear and also various case by case, the current ways to assess performance assumptions may result in a biased conclusion. The importance of each factor has then been analysed by varying this factor and fixing other factors. It has been revealed that the way of producing LR image, the variation of wavelet family and its wavelet functions, and the scale factor can substantially affect the performance of techniques. The selection of testing images with different features as well as the selection in of interpolation method can influence performance moderately. An optimal factor analysis approach has been proposed in this paper in order to improve the performance of existing techniques and better evaluate the overall performance of a technique. The OFA approach selects the optimal technique (including the selection of wavelet family as well as its wavelet functions and interpolation method) by simultaneously varying the way of producing LR image, enlargement factor, and testing images. The quantitative results reveal that the proposed method can significantly improve the performance of the WZP method. It also has potential to be extended to other wavelet-based methods. Results also reveal that the most important factors that have effectiveness on the performance are the method of producing LR image and the selection of wavelet function. For most of existing wavelet-based resolution enhancement techniques, the selection of these factors is very limited or never considered. The experimental results also indicate that the interpolation method has no significant effect in performance and the best interpolation method is not consistent for different techniques. More precisely, the selection of interpolation method for wavelet-based techniques can affect the performance, but this effect is not distinct. For the LR images obtained by downsampling using DWT with db.9/7, nearest neighbour, and low-pass filtering, wavelet-based techniques have the biggest potential to overtake the conventional interpolation methods. However, for the LR images produced by DWT with Haar, Bicubic, and Bilinear interpolation, wavelet-based techniques have no pronounced improvements over conventional interpolation methods. All these observations conclude that in order to assess more comprehensively and equitably for resolution enhancement techniques, variation of LR image generation method, scale factor, and wavelet functions must be considered, otherwise observed performance could be limited and biased.

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A Review on Vessel Extraction of Fundus Image to Detect Diabetic Retinopathy

By Prof. Dr. S. S. Chorage & Sayali.S.Khot
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Abstract- Ophthalmology is an important term of medical field, which helps to visualize various diseases and treat them accordingly. Fundus images are processed so as to treat diseases like glaucoma, vein occlusions, and diabetic retinopathy (DR), obesity, glaucoma etc. There are types of supervised and unsupervised types of algorithms used so as to segment the Fundus images. There are three types of datasets available DRIVE, STARE and CHASE_DB1. These data sets are being segmented with the help of Laplace operator. This method makes preprocessing of images by using adaptive histogram equalization by CLAHE algorithm. The first step is to extract green channel and segment this image by using Laplace operator.

GJCST-F Classification: I.4, B.4.2, I.3.3

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A Review on Vessel Extraction of Fundus Image to Detect Diabetic Retinopathy

Prof Dr. S. S. Chorage[α] & Sayali.S.Khot [σ]

Abstract- Ophthalmology is an important term of medical field, which helps to visualize various diseases and treat them accordingly. Fundus images are processed so as to treat diseases like glaucoma, vein occlusions, and diabetic retinopathy (DR), obesity, glaucoma etc. There are types of supervised and unsupervised types of algorithms used so as to segment the Fundus images. There are three types of datasets available DRIVE, STARE and CHASE_DB1. These data sets are being segmented with the help of Laplace operator. This method makes preprocessing of images by using adaptive histogram equalization by CLAHE algorithm. The first step is to extract green channel and segment this image by using Laplace operator. Thus it helps to enhance extraction of blood vessels from fundus image. The detected blood vessels and measurement of these vessel is used for diagnosis of Diabetic Retinopathy (DR) and other eye diseases.

I. Introduction

Segmentation of retinal blood vessel using fundus images has played an important role in assessing the severity of retina that leads to premature retinal diseases. In fundus image by analyzing the thickness of blood vessels any disease can be detected. The process of extraction analyze the amount of blood supplying the retina. The blood vessel blockages may cause the sight degradation and in the severe cases, blindness may occur. Irregularity of blood vessel diameter can be the first of eye disease like diabetic retinopathy or macula oedama. There are different types of techniques and algorithms that are being used for image segmentation. These algorithms are used for image validity and better accuracy.

II. Diabetic Retinopathy

Diabetes is happen to be a well known disease and is a major risk for cardiovascular diseases. It may cause abnormalities in the retina (diabetic retinopathy), kidneys (diabetic nephropathy), nervous system (diabetic neuropathy)etc. There are various types of diabetic eye disease that can cause vision loss and leads to blindness. Diabetes is therefore one of the most serious challenges to health care world-wide.

According to recent projections it has affected 239 million people in the year 2010. Diabetes has affected about 28 million in western Europe, 18.9 million in North America 138.2 million in Asia,1.3 million in Australasia. Sometimes the loss of vision irreversible due to diabetic retinopathy. However, early detection and treatment can reduce the risk of blindness by 95 percent. Because diabetic retinopathy often lacks early symptoms, people with diabetes should get a comprehensive dilated eye exam at least once a year.

III. Related Work

The majority of research work have focused on the algorithms used than the types of diseases. The algorithms are being justified for diabetic Retinopathy than any other diseases.

Sohini Roychowdhury et al.[1] have focused on unsupervised iterative blood vessel segmentation algorithm using fundus images which being used for different data sets. There is a stopping criteria used with the iterative algorithm for high resolution of fundus images. This algorithm helps to detect the density, tortuosity or width of the peripapillary vessels for analysis. This algorithm has about 90% of segmentation accuracy.

Walid M. Abdelmoula et al.[2] have proposed an iterative self organized data analysis(ISODATA) classifier that groups the pixels into distinguished regions by the observer. This method involves several steps to extract vectors of different pixels into different classes. This method helps in segmentation of Choroidal Neovascularization. It uses a linear time invariant system with a feedback loop proposed to describe the dilution of fluorescein.

Asiri Wijesinghe et al.[3] has introduced an Unsupervised adaptive k-means clustering algorithm that segment the original image to detect distinct abnormal regions and ANN. Fuzzy C-means algorithm is used for blood vessel tracking and needs no any information on edges. It under goes through several steps to detect fundus images.

Lama Seoud et al.[4] uses Adaptive Contrast Equalization method to separate red lesions, into microaneurysms (MA) and hemorrhages (HE). This is obtained by proposing several steps so as to extract the green channel from the optic disc. A novel red lesion detection method uses a set of shape features, the DSFs, were presented and evaluated on six different databases.

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IV. Proposed Methodology

Automatic detection of the blood vessels in retinal images is done with the help of set of data. The proposed method consists of two phases Vessel detection and processing of images.

There are three types of retinal image databases, namely, DRIVE, STARE and CHASE for evaluation.

a) *Structure of Eye*

The retina is a light-sensitive layer of nerve tissue lining the inner surface of the eye. The retina creates an image projected on its surface with help of the cornea and crystalline lens, and transforms it into nerve impulses sent to the brain.

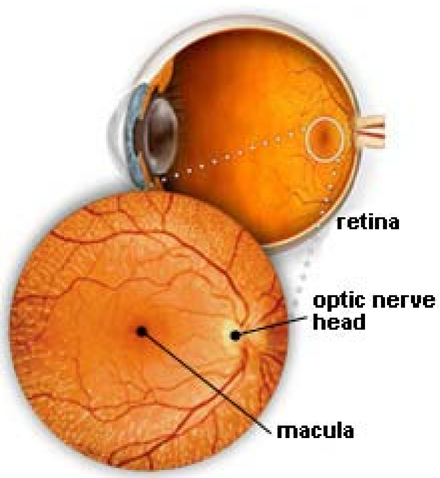

Figure 1: Anatomy of Eye and macula[12]

b) *Types of Datasets*

i. *DRIVE database*

DRIVE (Digital Retinal Images for Vessel Extraction) database, has of 40 color images, these images are of size 565×584 pixels, with a field of view of 45° and an approximate spatial resolution of 20 μm/pixel.

ii. *STARE database*

STARE (Structured Analysis of the Retina) dataset, consists of 81 fundus images that are digitized at 605×700 pixels has resolution, 24 bits per pixel (standard RGB).

iii. *CHASE_DB1 database*

CHASE_DB1 data set contains 28 colour images of retinal fundu images. A resolution of 1280x960 image pixels captured at 30 field of view .

V. Proposed Technique

The use of Laplace operator algorithm proposed blood vessels and veins extraction from Fundus image. The extraction of blood vessel involves several steps.

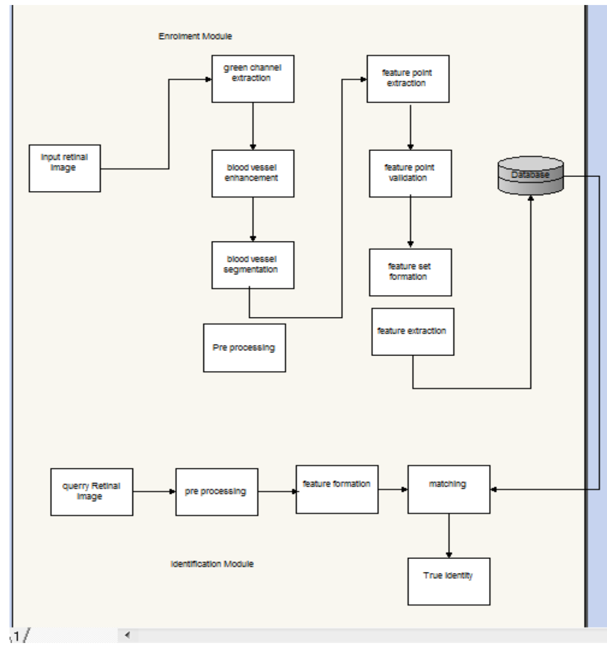

Figure 2: Algorithm for blood vessel extraction[12]

The very first step involved is the fundus image that is given as input. An Optical camera is used to see through the pupil of the eye to the inner surface of the eyeball. The resulting retinal image shows the optic nerve, fovea, and the blood vessels.

a) *Adaptive Histogram Equalization*

This process is being used so as to obtain the equalized image by choosing the green channel (RGBimage). It improves the quality of fundus image. The blood vessel then locates the optic disk.

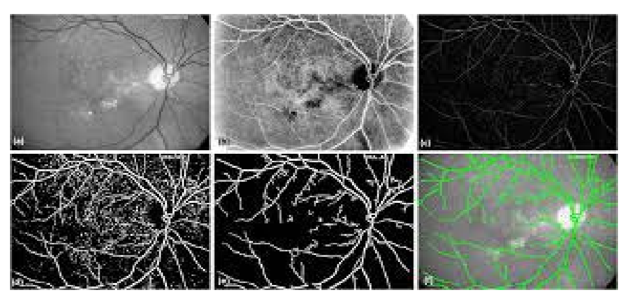

Figure 3: Segmented Image[12]

The method CLAHE –Contrast Limited Adaptive histogram equalization using OpenCV1 (Open Computer Vison) computes new value of brightness form surrounding pixels by forming a framework. This method is used to limit the noise by using the clip factor. The limit of clip factor is being set to 5000

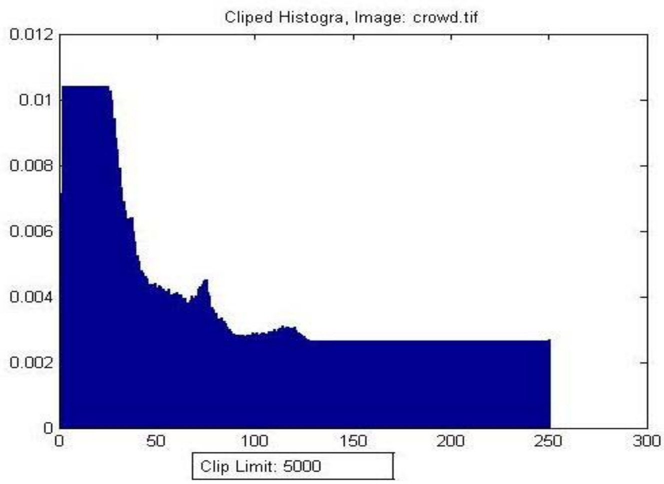

Figure 4: Histogram showing clip factor[12]

b) Laplace operator

The Laplace operator is being used for the edge detection which is based on second partial derivative. It can be obtained by using following expression

$$\nabla^2\mu = \frac{\partial^2\mu}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

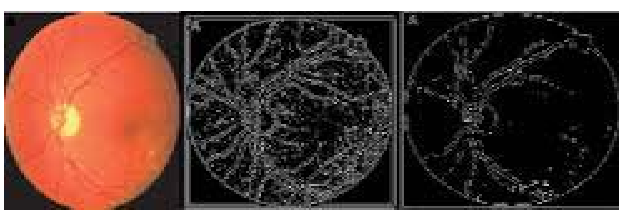

Figure 5: Fundun Image after using Laplace operator

The value of μ states the extracted green channel for (x,y).

c) Erosion Operation

The false structure that is being generated is being eroded to get a noise free amplified image. This operation helps to separate bonding of the pixels.

d) Small Segments Removed

The specific size of pixels for the used data is being selected other segmented having maximum size is being eroded. Thus we can see separate image.

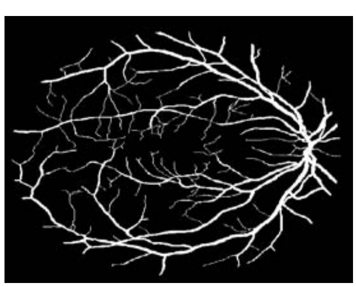

Figure 6: Removal of small segments image of 300 pixel

e) Detection of DR

The proposed Method thus helps to detect the Diabetic Retinopathy by the extraction process. The extracted image is scaled in[0,1](I). As we have retained the regions greater than 300 pixels is easy to detect the disease. Thus this processing makes it easy to analyze the DR for different set of data.

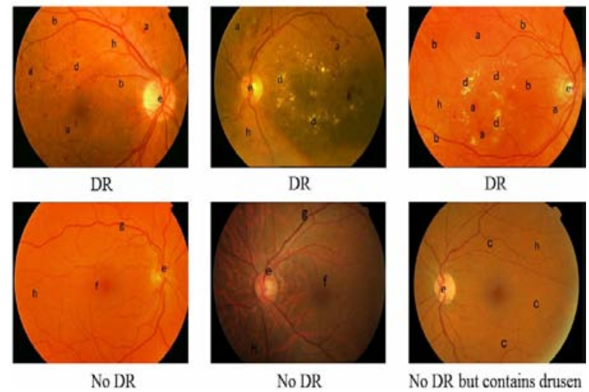

Figure 7: Datasets showing DR image

VI. Result

This is an output image obtained using MATLAB (Laplace operator) only the enhanced image of eye.

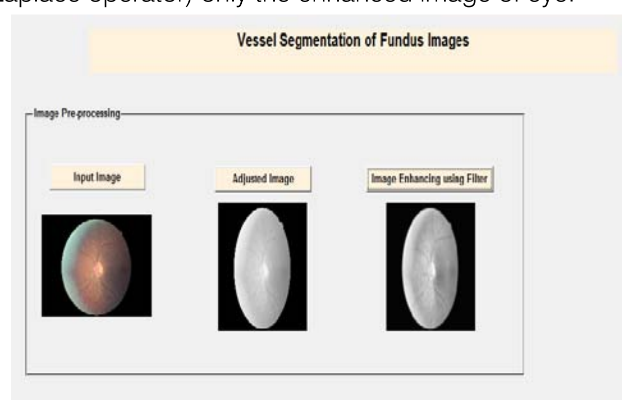

Figure 7: Output of preprocessing block

In the above Image, by using Laplace operator an enhanced image is being obtained that is used to obtain the filtered image which will further help to analyze the blood blockage in the vessels and thus results in detecting DR.

VII. Conclusion

In this paper review of Segmentation of fundus images approach have done, from this it is observed that analysis of retinal images is the key contributor detect DR Since its early detection is possible it helps to treat accordingly and thus the vision loss can be avoided. Studies such as the Diabetes Control and Complications Trial (DCCT) have shown that controlling diabetes slows the onset and worsening of diabetic retinopathy.

DCCT study participants who kept their blood glucose level as close to normal as possible were significantly less likely than those without optimal glucose control to develop diabetic retinopathy, as well as kidney and nerve diseases. Other trials have shown that controlling elevated blood pressure and cholesterol can reduce the risk of vision loss among people with diabetes. Thus segmenting fundus image plays vital role in early analysis of DR.

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Image Retrieval based on Macro Regions

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Abstract- Various image retrieval methods are derived using local features, and among them the local binary pattern (LBP) approach is very famous. The basic disadvantage of these methods is they completely fail in representing features derived from large or macro structures or regions, which are very much essential to represent natural images. To address this multi block LBP are proposed in the literature. The other disadvantage of LBP and LTP based methods are they derive a coded image which ranges 0 to 255 and 0 to 3561 respectively. If one wants to integrate the structural texture features by deriving grey level co-occurrence matrix (GLCM), then GLCM ranges from 256 x 256 and 3562 x 3562 in case of LBP and LTP respectively.

Keywords: *multi block, LBP; LTP; dimensionality; GLCM*

GJCST-F Classification: *I.3.3, B.4.2, H.2.8*

IMAGERETRIEVALBASEDONMACROREGIONS

Strictly as per the compliance and regulations of:

Image Retrieval based on Macro Regions

Bibi. Nasreen [α], V. Vijaya Kumar [σ] & A. Obulesu [ρ]

Abstract- Various image retrieval methods are derived using local features, and among them the local binary pattern (LBP) approach is very famous. The basic disadvantage of these methods is they completely fail in representing features derived from large or macro structures or regions, which are very much essential to represent natural images. To address this multi block LBP are proposed in the literature. The other disadvantage of LBP and LTP based methods are they derive a coded image which ranges 0 to 255 and 0 to 3561 respectively. If one wants to integrate the structural texture features by deriving grey level co-occurrence matrix (GLCM), then GLCM ranges from 256 x 256 and 3562 x 3562 in case of LBP and LTP respectively. The present paper proposes a new scheme called multi region quantized LBP (MR-QLBP) to overcome the above disadvantages by quantizing the LBP codes on a multi-region, thus to derive more precisely and comprehensively the texture features to provide a better retrieval rate. The proposed method is experimented on Corel database and the experimental results indicate the efficiency of the proposed method over the other methods.

Keywords: multi block, LBP; LTP; dimensionality; GLCM.

I. Introduction

With the development in the computer technologies and the advent of the internet, there has been bang in the amount and the difficulty of digital data being produced, stored, conveyed, analyzed, and accessed. The lots of this information are multimedia in behavior, comprising digital images, audio, video, graphics, and text information. In order to construct use of this enormous amount of data, proficient and valuable techniques to retrieve multimedia information based on its content need to be developed. In all the features of multimedia, image is the prime factor. Image retrieval techniques are splitted into two categories text and content-based categories. The text-based algorithm comprises some special words like keywords. Keywords and annotations should be dispenses to each image, when the images are stored in a database. The annotation operation is time consuming and tedious. Furthermore, the annotations are sometimes incomplete and it is possible that some image features may not be mentioned in annotations [1]. In a CBIR system, images are automatically indexed by their visual contents through extracted low-level features, such as shape, texture, color, size and so on [1, 2]. However, extracting all visual features of an image is a difficult task and there is a problem namely semantic gap. In the semantic gap, presenting high-level visual concepts using low-level visual concept is very hard. In order to alleviate these limitations, some researchers use both techniques together using different features. This combination improves the performance compared to each technique separately [3, 4]. A typical CBIR system automatically extract visual attributes (color, shape, texture and spatial information) of each image in the database based on its pixel values and stores them in to a different database within the system called feature database [5,6]. The feature data for each of the visual attributes of each image is very much smaller in size compared to the image data. The feature database contains an abstraction of the images in the image database; each image is represented by a compact representation of its contents like color, texture, shape and spatial information in the form of a fixed length real-valued multi-component feature vectors or signature. The users usually prepare query image and present to the system.

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II. Related Work

There are various method has been proposed to extract the features of images from very large database. Jisha. K. P, Thusnavis Bella Mary. I, Dr. A. Vasuki [7] proposed the semantic based image retrieval system using gray level co-occurrence matrix (GLCM) for texture attribute extraction. On the basis of texture features, semantic explanation is given to the extracted textures. The images are regained according to user contentment and thereby lessen the semantic gap between low level features and high level features. Swati garwal, A. K. Verma, Preetvanti Singh [8] proposed algorithm enlightened for image retrieval based on shape and texture features not only on the basis of color information. This algorithm [8] is skilled and examined for large image database. Xiang-Yang Wang, Hong-Ying Yang, Dong-Ming Li [9] proposed a new content-based image retrieval technique using color and texture information, which achieves higher retrieval effectiveness. The experimental results of this color image retrieval algorithm [9] is more accurate and efficient in retrieving the user-interested images. Heng Chen and Zhicheng Zhao [10] described relevance feedback method for image retrieval. Relevance feedback (RF) is an efficient method for content-based image retrieval (CBIR), and it is also a realistic step to shorten the semantic gap between low-level visual feature and high-level perception. SVM-based RF algorithm is proposed to advances the performance of image retrieval [10]. Monika Daga, Kamlesh Lakhwani [11] proposed a new CBIR classification using the negative selection algorithm (NSA) of ais. Matrix laboratory functionalities are being used to extend a fresh CBIR system which has reduced complexity and an effectiveness of retrieval is increasing in percentage depending upon the image type.S. Nandagopalan, Dr. B. S. Adiga, and N. Deepak [12] they proposed a novel technique for generalized image retrieval based on semantic contents. The algorithm [12] groupthree feature extraction methods specifically color, texture, and edge histogram descriptor. G. Pass [13]proposed a novel method to describe spatial features in a more precise way. Moreover, this model [13] is invariant to scaling, rotation and shifting. In the proposed method segmentations are objects of the images and all images are segmented into several pieces and ROI (Region of Interest) technique is applied to extract the ROI region to enhance the user interaction. Yamamoto [14] proposed a content-based image retrieval system which takes account of the spatial information of colors by using multiple histograms. The proposed system roughly captures spatial information of colors by dividing an image into two rectangular sub-images recursively.

Texture plays an important role in image processing applications. Texture and its features plays a major role in various image and video processing applications [15-29]. The local descriptors such as local binary pattern (LBP) have shown very promising discriminative ability in several applications [30]. The LBP is widely adopted in the Computer Vision research community for its simplicity as well as effectively [31]. Various variants of LBP are available through the published literature which is inspired by the great success of LBP. Some typical examples are Local Ternary Pattern (LTP) [32], Local Derivative Pattern (LDP) [33], Interleaved Intensity Order Based Local Descriptor (IOLD) [34], and Local Tetra Pattern (LTrP) [35]. These descriptors are mainly computed over the raw intensity values. In order to utilize the richer local information, many researchers performed some kind of preprocessing before the feature extraction. Some typical examples are Sobel Local Binary Pattern (SOBEL-LBP) [36], Local Edge Binary Pattern (LEBP) [37], Semi Structure Local Binary Pattern (SLBP) [38] and Spherical Symmetric 3D Local Ternary Pattern (SS-3D-LTP) [39]. James has compared the preprocessed images directly which is obtained by multiple filtering [40] for face recognition.

The rest of the paper organized as follows: Section III gives the proposed algorithm, section IV describes about results and discussions and finally section V conclude the paper.

III. Methodology

The present paper intends to reduce the dimensionality and complexity issues of LBP coded image while preserving the significant local texture features precisely and accurately. To address these issues, the proposing strategy divide the image into multi regions and on each region of the image, employed LBP quantization for CBIR. This strategy consist of seven steps

Step One: Compute HSV color histograms of the images using HSV quantization.

Step Two: Convert the color image into HSV color space as given below.

In color image processing, there are various color models in use today. In order to extract grey level features from color information, the proposed method utilized the HSV color space. In the RGB model, images are represented by three components, one for each primary color – red, green and blue. Hue is a color attribute and represents a dominant color. Saturation is an expression of the relative purity or the degree to which a pure color is diluted by white light. HSV color space is a non-linear transform from RGB color space that can describe perceptual color relationship more accurately than RGB color space. Based on the above the present paper used HSV color space model conversion.

HSV color space is formed by hue (H), saturation (S) and value (V). Hue denotes the property of color such as blue, green, red. Saturation denotes the perceived intensity of a specific color. Value denotes brightness perception of a specific color. However, HSV color space separates the color into hue, saturation, and value which means observation of color variation can be individually discriminated. In order to transform RGB color space to HSV color space, the transformation is described as follows:

The transformation equations for RGB to HSV color model conversion is given below i.e from equations 1 to 5.

$$V = \max(R, G, B) \quad (1)$$

$$\mathrm{S} = \frac{\mathrm{V} - \min(\mathrm{R,G,B})}{\mathrm{V}} \quad (2)$$

$$\mathrm{H} = \frac{\mathrm{G-B}}{6\mathrm{S}}\, if \quad \mathrm{V = R} \quad (3)$$

$$\mathrm{H} = \frac{1}{3} + \frac{\mathrm{B-R}}{6\mathrm{S}}\, if \quad \mathrm{V = G} \quad (4)$$

$$\mathrm{H} = \frac{1}{3} + \frac{\mathrm{R-G}}{6\mathrm{S}}\, if \quad \mathrm{V = B} \quad (5)$$

where the range of color component Hue (H) is [0,255], the component saturation (S) range is [0,1] and the Value (V) range is [0,255]. In this, the color component Hue (H) is considered as color information for the classification of facial images.

Step Three: convert the grey level image into a multi-region-LBP image [MR-LBP] as given below.

The ‘Local Binary Pattern’ (LBP) operator, first introduced by Ojala et al. [11], is a robust but theoretically and computationally simple approach for texture analysis. It brings together the separate statistical and structural approaches to texture analysis of both stochastic micro textures and deterministic macro textures simultaneously.

LBP is a simple operator. It is calculated by computing the binary differences between the grey value of a given pixel x and the grey values of its p neighboring pixels on a circle or radius R around x. the LBP operator is rotation invariant when the smallest value of p-1 bitwise shift operations on the binary pattern is selected. Local Binary Pattern (LBP) is based on the concept of texture primitives. This approach is a theoretically, computationally simple and efficient methodology for texture analysis. To represent the formations of a textured image, the LBP approach, models 3×3 neighborhood as illustrated in Figure 1. A 3×3 circular neighborhood consists of a set of nine elements, P = {pc, p0, p1, …, p7}, where pc represents the grey level value of the central pixel and pi (0≤i≤7) represent the grey level values of the peripheral pixels. Each 3×3 circular neighborhood then can be characterized by a set of binary values bi (0≤i≤7) as given in equation 6.

$$b_i = \begin{cases} 0 & \Delta p_i \geq 0 \\ 1 & \Delta p_i < 0 \end{cases} \qquad (6)$$

where Δpi= pi-pc.

For each 3×3 neighborhood, a unique LBP code is derived from the equation 7.

$$LBP_{P,R} = \sum_{i=0}^{i=7} b_i \times 2^i \qquad (7)$$

Every pixel in an image generates an LBP code. A single LBP code represents local micro texture information around a pixel by a single integer code LBP ϵ [0, 255].

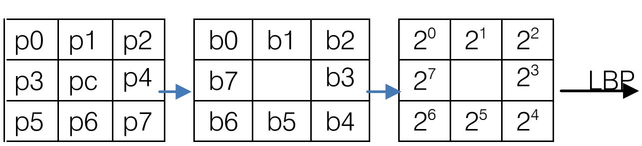

Figure 1: Representation of LBP

The $LBP_{P,R}$ operator produces 2^P different output values, corresponding to the 2^P different binary patterns that can be formed by the P pixels in the neighbor set. Achieving rotation invariance, when the image is rotated, the grey values gp will correspondingly move along the perimeter of the circle, so different $LBP_{P,R}$ may be computed. To achieve rotational invariance a unique identifier to each LBP is assigned in the present paper as specified in equation 8.

$$LBP^{ri}_{P,R}(x, y) = \min\{ROR(LBP_{P,R}, i)|\ i = 0,1,2, \dots, P-1\} \qquad (8)$$

where the superscript ‘ri’ stands for “rotation invariant”. The function $ROR(LBP_{P,R}, i)$ performs a circular bit-wise right shift on the P-bit number $LBP_{P,R}$i times to the right (|i| < P). LBP is a local texture operator with low computational complexity and low sensitivity to changes in illumination LBP has the following advantages.

1. The local texture character can be described efficiently.
2. It is easy to use.
3. The whole image character description can be easily extended.

Though LBP is widely used in various image classification and recognition approaches, but it suffers with following disadvantages.

1. In the course of analysis, its window size is fixed.
2. It neglects the effect of the central pixel in local region.
3. It can’t avoid the variety of local greyscale caused by the illumination.
4. Sensitive to image rotation.
5. Loss of global texture information.
6. Sensitive to noise.

Step Three (a): Formation of Multi Region Local Binary Pattern (MR-LBP)

The basic LBP operators with any (P, R) (where P corresponds to the number of neighboring pixels on a circle of radius of R) only capable of extracting features on small spatial neighborhood i.e. micro level features and thus they fail in capturing larger scale structures or macro structures which are also dominant and essential features on faces. Further the grey level comparison between center pixel and the neighboring pixel may also prone to noise effect, especially when the neighboring pixels grey level values are equal or less than one to centre pixel value [41]. To overcome this Multi Region Local Binary Pattern (MB-LBP) features are introduced in the literature [42, 43]. The Multi Region Local Binary Pattern (MR-LBP) approach maintains the size of the region as V *W where V and W are multiples of three. The region of size V * W is subdivided into nine multi regions LBP’s of size N*M where N=V/3 and M=W/3. This gives the uniformity in the formation of MR-LBP. The mechanism of encoding a large neighborhood or square region into LBP is the basis for MR-LBP. The region size VxW denotes the scale of MR-LBP for R=3 and S=3, it particularly derives the basic LBP and in this case N=1 and M=1.

The average value of each of the nine sub regions represents the grey level value of pixels of basic LBP. Based on this LBP code is generated and this represents the MR-LBP code. The scalar values i.e. average pixel grey level values of each sub region of size N*M can be computed very efficiently from integral image. Therefore MR-LBP features extraction process is very fast. However it only incurs a little more cost when compared to basic LBP operator (8,1). Even as 'P' increases the basic LBP feature extraction becomes costlier. The basic parameters V and W of the MR-LBP influence the overall structure of the features. If V and W are small then MR-LBP captures only the local features and when V and W are large (especially V and W>=9) the MR-LBP captures both micro and macro structure features. The average grey level values of sub regions N*M over comes the noise effect, makes MR-LBP as robust, and provides large scale information in addition to micro level information. The MR-LBP mechanism on a region size9*9 is shown in Figure 2, the block sizes are 3*3.

50	24	20	15	12	23	18	19	24
51	25	19	33	12	16	31	32	12
43	49	16	15	45	18	28	27	34
24	23	15	11	10	14	21	22	45
25	19	14	12	11	15	23	24	53
24	20	16	51	15	14	28	29	34
24	49	26	18	25	23	9	24	13
31	42	23	4	5	15	17	28	1
14	12	13	11	15	19	5	11	9

(a)

33	21	25
20	17	31
26	15	13

(b)

1	1	1
1		1
1	0	0

(c)

(207)10

(d)

Figure 2: Multi Region-Local Binary Pattern Code generation (a) Division of Region of size 9*9 into '9' sub regions of 3*3 (b) Representation of average values of '9' sub region of 3*3 (c) MR-LBP Representation (d) MR-LBP Code.

The MR-LBP code is evaluated in the same way as represented in equation 6 and 7. This way the MR-LBP code represents some advantages:

- It is robust
- MR-LBP can be calculated efficiently using integral images
- The MR-LBP represents both micro structures i.e. by taking the average of each block and also macro structures by representing 9 blocks under single 3*3 neighborhood.
- The resulting binary patterns as features of MR-LBP can detect diverse image structures such as lines, edges, spots, corners [67] at different scale and location.
- There will be fewer number MR-LBP code features when compared to basic LBP. A basic LBP with image dimension PxQ generates(P-1)*(Q-1) LBP codes, where as a MR-LBP with a region size of VxW generates a total number of (P*Q)/(V*W) LBP codes in a non-overlapped manner. Therefore the implementation of the MR-LBP code feature selection is significantly easier.

Step Four: To overcome the high dimensionality problem the present paper quantized the MR-LBP coded image in to 10 levels ranging from 0 to 9. This reduced the dimension of the GLCM into 10 x 10. The quantization process is done using the following equation 9.

$$I(x,y) = \begin{cases} 0 \; if I(x,y) \geq 0 \; and I \; (x,y) < 26 \\ 1 \; I(x,y) \geq 26 \; and I \; (x,y) < 50 \\ 2 \; I(x,y) \geq 50 \; and I \; (x,y) < 75 \\ 3 \; I(x,y) \geq 75 \; and I \; (x,y) < 100 \\ 4 \; I(x,y) \geq 100 \; and I \; (x,y) < 125 \\ 5 \; I(x,y) \geq 125 \; and I \; (x,y) < 150 \\ 6 \; I(x,y) \geq 150 \; and I \; (x,y) < 175 \\ 7 \; I(x,y) \geq 175 \; and I \; (x,y) < 200 \\ 8 \; I(x,y) \geq 200 \; and I \; (x,y) < 225 \\ 9 \; I(x,y) \geq 225 \; and I \; (x,y) \leq 255 \end{cases} \quad (9)$$

Step Five: Derive GLCM on quantized MR-LBP coded image. The GLCM is constructed with varying distances d =1, 2, 3 and 4. And on each d four GLCM's are constructed with 0°, 45°, 90° and 135°. Thus the present paper derived sixteen GLCM's and four GLCM's on each di = {1, 2, 3, 4} .

The grey level co-occurrence matrix (GLCM) was introduced by Haralick et al. [44]. It is a second order statistical method which is reported to be able to characterize textures as an overall or average spatial relationship between grey tones in an image [45]. Its development was inspired by the conjectured from Julesz [46] that second order probabilities were sufficient for human discrimination of texture. The GLCM approach has been used in a number of applications, e.g.[47-51]. In general, GLCM could be computed as follows. First, an original texture image D is re-quantized into an image G with reduced number of grey level, Ng. A typical value of Ng is 16 or 32. Then, GLCM is computed from G by scanning the intensity of each pixel and its neighbor, defined by displacement d and angle ø. A displacement, d could take a value of 1,2,3,…n whereas an angle, ø is limited 0°, 45°, 90° and 135°.

Step Six: Derive GLCM features with 0°, 45°, 90° and 135° on each di ={1,2,3,4} . The average values of 0°, 45°, 90° and 135°are considered by the present paper as feature vectors for image retrieval.

From the literature survey, the present paper found the 'grey level co-occurrence matrix' (GLCM) is a benchmark method for extracting Haralick features such as [44] (angular second moment, contrast, correlation,

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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 [48] (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 GLCM features are defined below.

$$P_x(i) = \sum_{j=0}^{G-1} P(i,j)$$

$$P_y(j) = \sum_{i=0}^{G-1} P(i,j)$$

$$\mu_x = \sum_{i=0}^{G-1} i \sum_{j=0}^{G-1} P(i,j) = \sum_{i=0}^{G-1} i P_x(i)$$

$$\mu_y = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} j P(i,j) = \sum_{j=0}^{G-1} j P_x(j)$$

$$\sigma^2{}_x = \sum_{i=0}^{G-1} (i-\mu_x)^2 \sum_{j=0}^{G-1} P(i,j) = \sum_{i=0}^{G-1} \left(P_x(i) - \mu_x(i)\right)^2$$

$$\sigma^2{}_y = \sum_{j=0}^{G-1} \left(i-\mu_y\right)^2 \sum_{i=0}^{G-1} P(i,j) = \sum_{j=0}^{G-1} \left(P_y(j) - \mu_x(j)\right)^2$$

and

$$P_{x+y}(k) = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} P(i,j)\; i + j = k$$

for k=0, 1, 2, 3…,2(G-1).

$$P_{x-y}(k) = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} P(i,j) \quad |i-j| = k$$

for k=0, 1, 2, 3…,(G-1).

where G is the number of grey levels used. μ is the mean value of P.

μ_x, μ_y, σ_x and σ_y are the means and standard deviations of Px, Py. Px(i) is ith entry in the marginal-probability matrix obtained by summing the rows of P(i, j).

- Homogeniety, Angular Second Moment (ASM):

$$\text{ASM} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \{P(i,j)\}^2 \quad (10)$$

ASM is a measure of homogeneity of an image. A homogeneous scene will contain only a few grey levels, giving a GLCM with only a few but relatively high values of P (i, j). Thus, the sum of squares will be high.

- Energy

$$\text{Energy}: \sum_{i,j} P(i,j)^2 \quad (11)$$

- Local Homogeneity, Inverse Difference Moment (IDM)

$$\text{IDM} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{1}{1+(i-j)^2} \text{P(i,j)} \quad (12)$$

IDM is also influenced by the homogeneity of the image. Because of the weighting factor (1+(i−j) 2) −1 IDM will get small contributions from inhomogeneous areas (i != j). The result is a low IDM value for inhomogeneous images, and a relatively higher value for homogeneous images.

- Contrast :

$$\text{Contrast} = \sum_{n=0}^{G-1} n^2 \left\{\sum_{i=1}^{G} \sum_{j=1}^{G} P(i,j)\right\}, |i-j| = n \quad (13)$$

This measure of contrast or local intensity variation will favor contributions from P (i, j) away from the diagonal, i.e. i ! = j.

- Correlation :

$$\text{Correlation} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{\{iXj\}XP(i,j) - \{\mu_x X \mu_y\}}{\sigma_x X \sigma y} \quad (14)$$

Correlation is a measure of grey level linear dependence between the pixels at the specified positions relative to each other.

- Entropy :

$$\text{Entropy} = -\sum_{i=0}^{G-1} \sum_{j=0}^{G-1} P(i,j) X \log\left(P(i,j)\right) \quad (15)$$

Inhomogeneous scenes have low first order entropy, while a homogeneous scene has high entropy.

- Sum of Squares, Variance:

$$\text{VARIANCE} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} (i-\mu)^2 P(i,j) \quad (16)$$

This feature puts relatively high weights on the elements that differ from the average value of P(i, j).

- Sum of Average :

$$\text{AVERAGE} = \sum_{i=0}^{2G-1} i P_{x+y}(i) \quad (17)$$

- Sum Entropy(SENT) :

$$\text{SENT} = -\sum_{i=0}^{2G-2} P_{x+y}(i) log\left(P_{x+y}(i)\right) \quad (18)$$

- Difference Entropy(DENT):

$$\text{DENT} = -\sum_{i=0}^{G-1} P_{x+y}(i) log\left(P_{x+y}(i)\right) \quad (19)$$

- Inertia :

$$\text{INERTIA} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \{i-j\}^2 X P(i,j) \quad (20)$$

- Cluster Shade :

$$\text{SHADE} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \left\{i + j - \mu_x - \mu_y\right\}^3 X P(i,j) \quad (21)$$

- Cluster Prominence:

$$\text{PROM} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \left\{i + j - \mu_x - \mu_y\right\}^4 X P(i,j) \quad (22)$$

Step Seven: Use similarity distance measure for comparing the query image feature vector and feature vectors of the database images.

The present model extracts all 16 GLCM features on the MR-LBP and also HSV color space histograms on the database images and query image. The present retrieval model selects 16 top images from the database images that are matching with query image. And also experimented with more number of top images and retrieval performance is measured. The image retrieval is accomplished by measuring the distance between the query image and database images. The present paper used Euclidean distance as the distance measure and as given below

$$Dist_s(T_n, I_n) = \left(\sum_{i,j=1} \left|f_i(T_n) - f_j(I_n)\right|^2\right)^{1/2} \quad (23)$$

Where Tn query image, In image in database;

IV. Results and Discussions

The present paper carried out image retrieval on Corel database [52]. This database consists of a large number of images of various contents ranging from animals to outdoor sports to natural images. These images have been pre classified into different categories each of size 100 by domain professionals. Researchers are of the opinion that the Corel database meets all the requirements to evaluate an image retrieval system, due to its large size and heterogeneous content. For our experiment, we have collected 1000 images form database compromising 10 classes. That is each class consists of 100 images. The classes of image are displayed in Figure 3 i.e. African, Sea shore, Tombs, Bus, Dinosaur, Elephants, Fancy Flowers, Horses, Valleys and Evening Skies. Each category has images with resolution of either 256x384 or 384X256. The performance of the present model is evaluated in terms of average precision (APR), average recall rate (ARR) and accuracy. Precision is the ratio of number of retrieved images Vs. the number of relevant images retrieved. The recall is the ratio of number of relevant image retrieval Vs. total number of relevant images in the database.

$$precision = \frac{Numberofrelevantimagesretried}{Totalnumberofimage\quad sretrieved} \quad (24)$$

$$Recall = \frac{Numberofrelevantimagesretrieved}{Totalnumberofrelevantimagesindatabase} \quad (25)$$

$$APR(n) = \frac{1}{N_C}\sum_{i=1}^{N_C} precision\,(I_{i,}) \quad (26)$$

$$ARR(n) = \frac{1}{N_C}\sum_{i=1}^{N_C} recall\,(I_{i,}) \quad (27)$$

$$Accuracy = \frac{APR(n) + (ARR(n))}{2} \quad (28)$$

Where $precision\,(I_{i,})$ is precision value of image I_i, Nc is number of images in each category.

The present paper compute GLCM features on MR-QLBP using various distance values: D = 1, 2, 3, 4 and color histograms. The query matching is performed using Euclidean distance. The present retrieval model selects 16 top images from the database images that are matching with query image. And also experimented with more number of top images and retrieval performance is measured. Figure 4(a)- 4(e) shows five examples of retrieval images, i.e. one image from each class, by the proposed method with D=4 for 16 top matched images and top left most image is the query image.

Figure 3: Considered 10 classes of Corel database from top left to bottom right African, Sea shore, Tombs, Bus, Dinosaur, Elephants, Fancy Flowers, Horses, Valleys and Evening Skies.

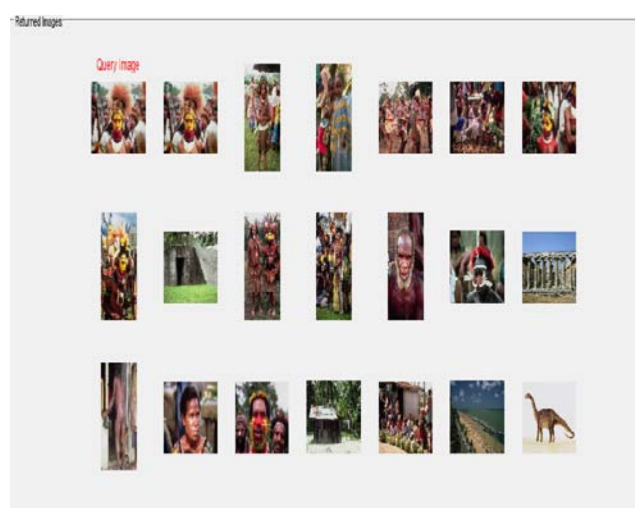

Figure 4(a): Retrieved African images by the proposed method

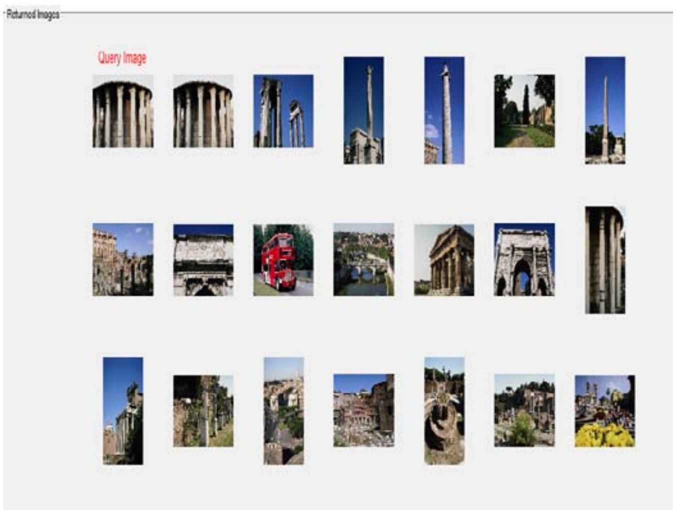

Figure 4 (b) : Retrieved monuments by the proposed method

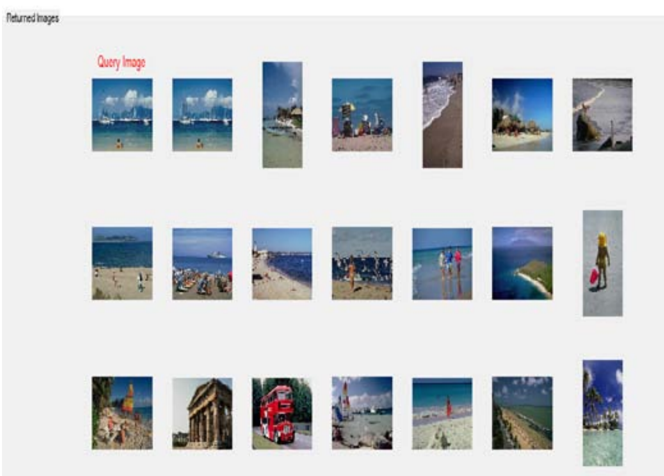

Figure 4(c): Retrieved beach sand images by the proposed method

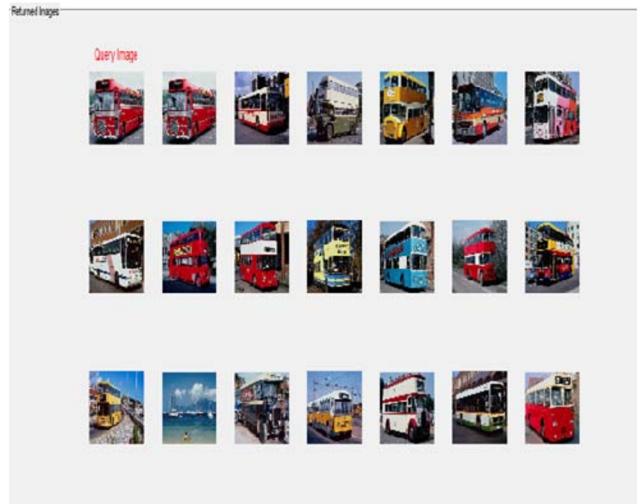

*Figure 4 (d):*Retrieved busses by the proposed method

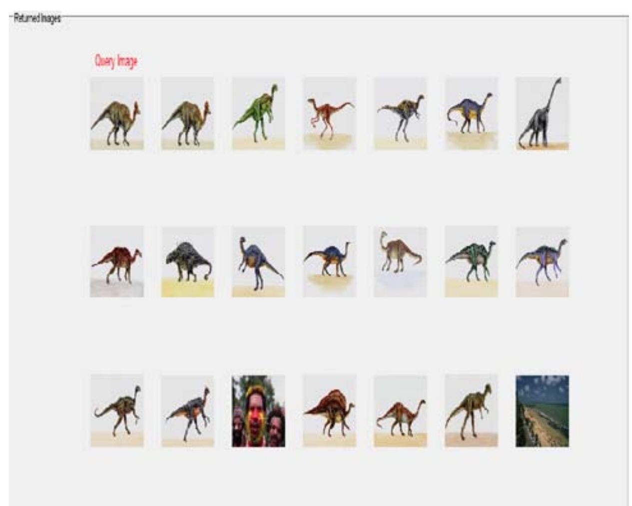

Figure 4(e): Retrieved dinosaurs by the proposed method

The average precision, recall rates and accuracy computed based on MR-QLBP and HSV histograms listed in Tables 1. The best performance of integrated Q-LBP is obtained when D = 4. The average precession, recall rates and accuracy of proposed method for different d values are plotted in graphs, indicated in Figure 5, Figure 6 and Figure 7 respectively.

Table 1: Average precision rate of all classes of images with various distance measures for 16 top matched images

Proposed method		Distance parameter			
		d=1	d=2	d=3	d=4
MR-QLBP	Precision	0.70	0.71	0.72	0.74
	Recall	0.37	0.41	0.42	0.44
	Accuracy	0.54	0.56	0.57	0.59

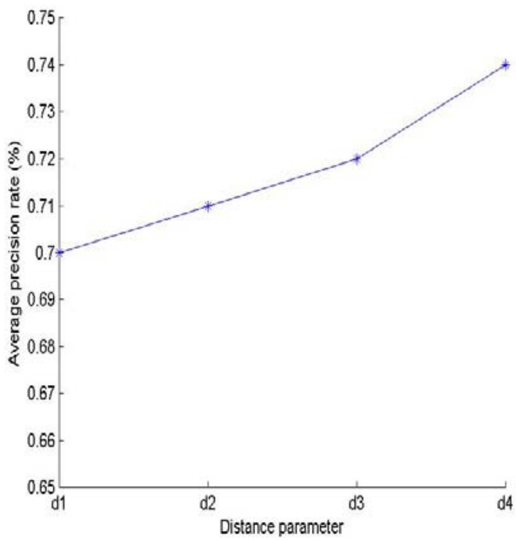

Figure 5: Average precision graph for proposed method (MR-QLBP) for different d values

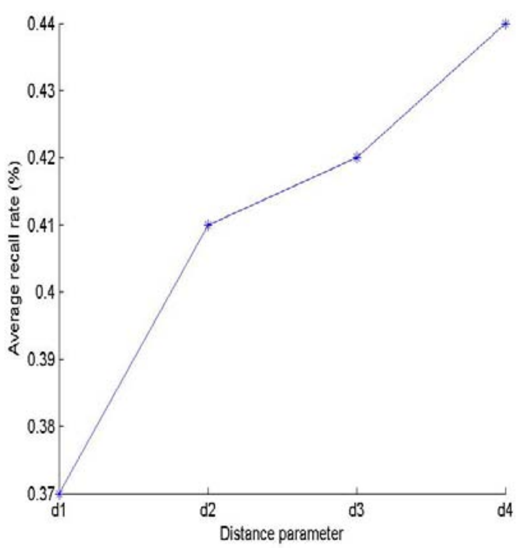

Figure 6: Average recall graph for proposed method (MR-QLBP) for different d values

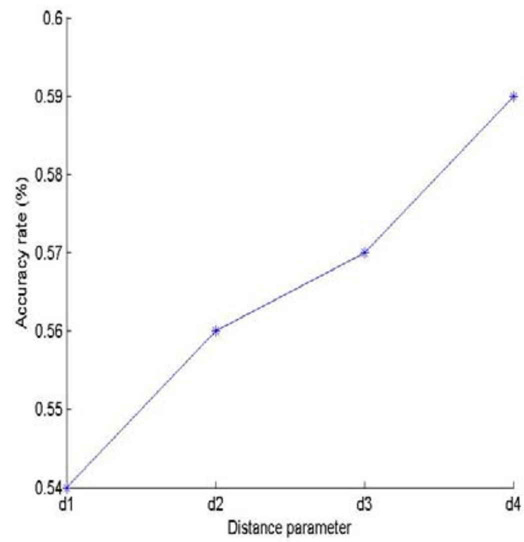

Figure 7: Accuracy graph for proposed method (MR-QLBP) for different d values

The average precision rate of proposed method MR-QLBP and existing methods i.e. hierarchical clustering algorithms (HCA), Content Based Image Retrieval Using Clustering (CBIR-C), Fuzzy C-Means clustering scheme (FCMC) is given in Table 2 and plotted graphs as shown in Figure 8, Figure 9 and Figure 10. From these graphs, it is clearly seen that the proposed MR-QLBP outperforms the HCA, CBIR-C, and FCMC over the considered database using both ARP, ARR and average accuracy evaluation metrics.

Table 2: Average precession rate on each class of images between existing and proposed method for 16 top retrieved images

	Image category and the precision (%)					
Methods	Africans	monuments	Sand	Buses	Dinosaurs	Average
HCA [53]	0.39	0.42	0.44	0.48	0.5	0.45
CBIR_C[54]	0.4	0.43	0.46	0.49	0.52	0.46
FCMC[55]	0.61	0.6	0.66	0.67	0.7	0.64
MR-QLBP	0.69	0.71	0.73	0.74	0.72	0.72

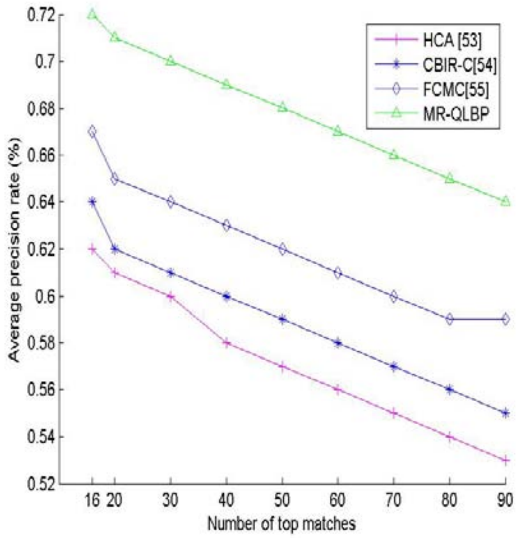

Figure 8: Average Performance curve (precision) using HCA, CBIR-C, FCMC and proposed MR-QLBP method

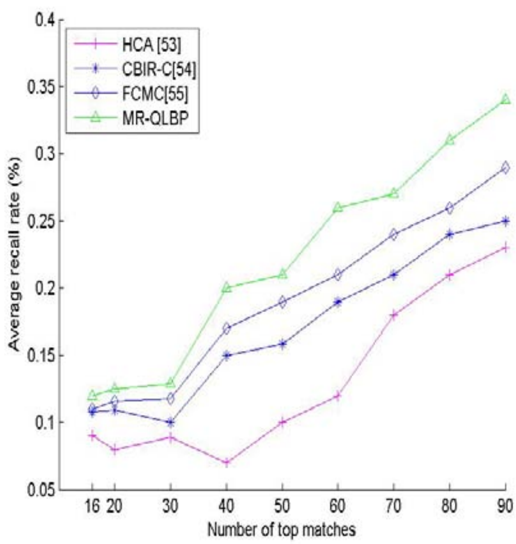

Figure 9: Average Performance curve (recall) using HCA, CBIR-C, FCMC and proposed MR-QLBP method

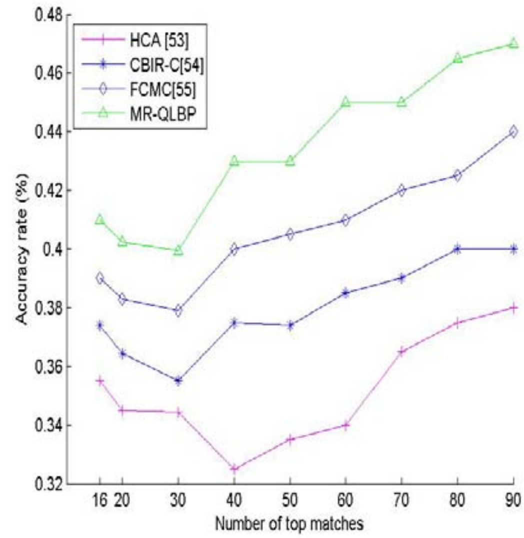

Figure 10: Average accuracy graph using HCA, CBIR-C, FCMC and proposed MR-QLBP method

V. Conclusions

The present paper has proposed and successfully implemented the quantized approach for image retrieval i.e. MR-QLBP on Corel databases. The proposed MR-QLBP captured image features efficiently. The GLCM features are evaluated and retrieval performance is noted using average precision, average recall and accuracy parameters. The proposed method showing evocative performance compare with other existing methods. The proposed method also compared with the existing methods and the precision and recall graphs indicates the high performance of the proposed method when compared with existing methods HCA, CBIR-C and FCMC.

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Fast Search Approaches for Fractal Image Coding: Review of Contemporary Literature

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Abstract- Fractal Image Compression (FIC) as a model was conceptualized in the 1989. In furtherance, there are numerous models that has been developed in the process. Existence of fractals were initially observed and depicted in the Iterated Function System (IFS), and the IFS solutions were used for encoding images. The process of IFS pertaining to any image constitutes much lesser space for recording than the actual image, which has led to the development of representation the image using IFS form, and how the image compression systems has taken shape. It is very important that the time consumed for encoding has to be addressed for achieving optimal compression conditions and predominantly the inputs that are shared in the solutions proposed in the study, depict the fact that despite of certain developments that has taken place, still there are potential chances of scope for improve- ment.

GJCST-F Classification: *H.2.8*

FASTSEARCHAPPROACHESFORFRACTALIMAGECODINGREVIEWOFCONTEMPORARYLITERATURE

Strictly as per the compliance and regulations of:

Fast Search Approaches for Fractal Image Coding: Review of Contemporary Literature

Srinivasa RaoD [α] & Dr. Subhash Chandra N [σ]

Abstract- Fractal Image Compression (FIC) as a model was conceptualized in the 1989. In furtherance, there are numerous models that has been developed in the process. Existence of fractals were initially observed and depicted in the Iterated Function System (IFS), and the IFS solutions were used for encoding images. The process of IFS pertaining to any image constitutes much lesser space for recording than the actual image, which has led to the development of representation the image using IFS form, and how the image compression systems has taken shape. It is very important that the time consumed for encoding has to be addressed for achieving optimal compression conditions and predominantly the inputs that are shared in the solutions proposed in the study, depict the fact that despite of certain developments that has taken place, still there are potential chances of scope for improvement. From the review of exhaustive range of models that are depicted in the model, it is evident that over period of time, numerous advancements have taken place in the FCI model and is adapted at image compression in varied levels. This study focus on the existing range of literature on FCI and the insights of various models has been depicted in this study.

I. Introduction

Fractal Image Compression (FIC) as a model was conceptualized by Barnsley [1] and over a period of time, the first of its kind of such a model implementation is carried out by Jacquin in 1992 [2]. The underlying concept that has supported in development of an effective model is on the basis of partitioned iteration function system (PIFS), where the self-similarity property has been adapted for achieving the desired compression [3].

In 1982, Mandelbrot a reputed mathematician has proposed the conceptual development of Fractal [4], which was used by Barnsley [1] in introducing the model in the year 1988, which was advanced and realized to the implementation levels in further stages by Jacquin [2], by providing practical coding algorithm designed on the basis of PIFS.

There shall be much of redundant information in majority of natural and also the artificial objects, in the form of repeated patterns called as fractals [5], which normally occur in all levels and could be envisaged as virtually identical, in various positions and sizes. Existence of fractals were initially observed and depicted in the Iterated Function System (IFS) [6], and the IFS solutions were used for encoding images. The process of IFS pertaining to any image constitutes much lesser space for recording than the actual image, which has led to the development of representation the image using IFS form, and how the image compression systems has taken shape. FIC (Fractal Image Compression) is certainly an effective method of portraying the nature images in a loss image compression. In the FIC method, rather than adapting the pixels method, the fractals are adapted for improving the system, and in fractal image, the image comprise contractive affine mappings for the entire image.

In a conventional approach of fractal image compression developed on the basis of collage theorem, in which the estimation of the distances between the image that are to be encoded and the fixed point of a transform for an image is estimated as collage error. But the crux for effective image compression is that the collage error should be very much minimal as possible. [7],[8]. Even in the process of retrieval, the method of self-similarity model has been very effective. However, one of the key challenges in the process fractal image compression method is the time consumed for the encoding purpose.

Profoundly, the method of fractal image compression is adapted in the process of image signature solutions [9] and texture segmentation process [10]. Also in the process of image retrievals [11, 12] and the distinct methods like MR and ECG based image processing [13], too the method of Fractal Image Compression models are adapted, But the issues pertaining to lengthier encoding time is turning out to be a major setback in the model.

For instance, in the process of encoding, it is very essential to evaluate the high volume domain blocks for similarity evaluation with range blocks, and in the scenario of range blocks that are of $n \times n$, size within an image of $N \times N$ shall be $(N/n)^2$, whilst the number of domain blocks could be $(N-2n+1)^2$. It can be denoted from the computation of vivid range of blocks that if any of the blocks are matching and also the complexity of the domain blocks are also evaluated as $O(N^4)$ [14]

As predominantly the time consumed is high in terms of computing the similarity measures for the large amount and still there is significant scope for process

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improvement in the area of reducing the encoding time, which can facilitate in improving the system efficiency.

In terms of reducing the encoding time, there are numerous models that were proposed earlier. For instance, the concept of image redundancies is efficiently used by focusing on block of self-affine transformations, which could lead to fractal image compression solution (FIC). Numerous methods have been targeted in terms of addressing the conditions of encoding time, but one of the common ways that has been envisaged in the process is about the classification of blocks to a varied sets having range and domain blocks for the same set selected for matching.

The impact of such process is about reducing the encoding time, but the quality of the image might be jeopardized in such conditions. Reducing the size of a domain pool could be another significant method adapted in several ways. In a model proposed in [15] the domain blocks with little entropies shall be deleted from the domain pool [14], and in additional to the size of domain pool, as computational cost of matching a range block and also the domain block has significant in the encoding time. Such costs have been reduced by focusing on approximate optimum values for contrast scaling factor rather than search for it. A new model of [14] has been proposed in the combination of aforesaid points, and the new fractal image coding that is proposed has been one of the most effective methods resulting in much lesser encoding time.

Fractal coding is considered to be one of the most effective codec methods, and there are many academic researchers focusing on the process for more designing the models that could achieve more effective compression ratio, high levels of decoding speed, independent resolutions etc. [16],[17],[18]. In the other dimension, it also focus on other kind of image processing applications, which has image retrieval [19] solutions, elimination of image noise [20] [21] and the digital water marking solutions [22] [23].

Among the very popular approaches towards fractal video sequence coding, in the first model, the extension of still-image related scheme to three-dimensional blocks of video are adapted. Despite the fact that in such model the data compression is effective, still the quality levels are not up to standards as severe blocking artifacts are envisaged in the process.

The other model adapted in the combination of intra-frame and the motion-compensated ways of inter-frame fractal coding is the second popular model adapted. Significant method like hybrid circular prediction mapping and the non-contractive inter-frame mapping $(CPM / NCIM)$ [24] in which the fractal video coding is combined with usually adapted motion estimation and motion compensation (ME / MC) based algorithm.

In such a model, (ME / MC) it focus on high temporal correlations amid of adjacent frames. The key difference in the process is about how CPM shapes up. CPM has to be contractive to the iterative decoding process for convergence, but NCIM need not be contractive in such instances due to the fact that the decoding of NCIM has been on decoded, frame sand is non-iterative. In the current solutions, the CPM frames are decoded using 6 iterations, and majorly the NCIM frames are usually coded with earlier reference frame. Both inter/intra coding and the three dimensional fractal block coding techniques are resulting of resolution-independent model in the spatial domain. NAL indicates the bit stream which is formed on the basis of representation of coded pictures and also the associated data taking place from the coded video sequence.

The kind of digital developments that are taking place and the volume of image creations and image processing that is taking place, it is imperative that there are significant developments that are taking place in the process and still the issues of reducing the encoding time is not addressed effectively in the system and there is profound scope for research in such models. However, to ensure that the study has reviewed in-depth about various kinds of challenges envisaged in the process, extensive review of literature is carried out to understand the scope and efficacy of the existing systems, and the areas in which there are significant chances of development.

II. Review of Literature

Numerous research studies has been carried on the image processing and in many of such image related studies, Fractal image compression (FIC) has been the centric point. In many of the earlier studies, there are significant inputs related to how some of the classification methods were normally adapted, in which the preprocessing step primarily constitutes classification of ranges and domains. However, one of the key factors to be taken in to consideration is about how at every search only, only domains that has similar class has been assessed. [25],[26],[27], but the domain pool reduction is other effective technique that was proposed for reducing the encoding time. Predominantly the method in which the location of search space to the blocks for which the spatial location is close to the range location [28],[29] has been predominantly used in the process.

Wavelet transformation is the other solution that is adapted, in which the original image is decomposed to various frequency sub-bands for extracting the attributes from the wavelet coefficients related to varied sub-bands. Distribution of such wavelet coefficients shall be resourceful in multi scale classification of a document image which is context based [30]. In order to surface data by using the wavelet transform coefficients, from the triangular mesh, fast and efficient algorithm was adapted [31], as it directly identifies the local area complexities for an image and divides the square cells on the basis of complexity. In [32], the authors have focused on the model of hybrid image classification method which focuses on combining the wavelet transform, artificial neural network and rough set approach. In another study, Zou and Li have proposed the method of wavelet coefficients for low-pass bands [53], and such an approach is dependent on the distribution of histograms for wavelet coefficients.

In the recent studies, adaptation of PSO to the fractal images compression model has been proposed. In the proposed application, PSO based Huber FIC (HFIC) [34], shall be robust against any kind of outliers in the image and shall support in reducing the encoding time. Also, there are many other methods like image correlation, spatial correlation method which denotes the neighbor blocks that usually have some similar properties for edge relation, which can support in reducing the encoding time.

In other dimension, if one block has some kind of vertical edge, either the upper or lower block shall have similar kind of vertical edge, and using such properties the searching space shall be reduced, thus resulting in much faster encoding speeds. In [35], the authors have focused upon SC-GA method in which the combination of spatial correlation and also the genetic algorithm towards improving the encoding speed has been proposed. Also, the proposed model shall support in improving the quality of image retrieved. In [36], a direct allocation method has been proposed for predicting best Dihedral transformation which is based on lowest three DCT coefficients. The drawbacks of such methods are about comparing the DCT coefficients for a given range block and domain block as per the current search entry. Also, some of the content-based query was also developed in which the fractal properties of images were considered [37].

The other way of decreasing the encoding time is by focusing on stochastic optimization methods which could be adapted using GA (Genetic Algorithm). There are many prevalent methods of reducing encoding time that has been proposed on GA based solutions. [38]. Idea of special correlation for an image shall be used in methods, while the chromosomes in GA comprise all range of blocks that could lead to high encoding speed. Some of the other researchers also found improvements using the tree structure search methods for the search process and also using the parallel search methods [39] [40] for improving the encoding speed.

Among the other methods that were discussed in the earlier models, the accelerated encoding technique presented focus on reducing the huge encoding time. As per the Fisher's classification method [41], the image blocks shall be categorized in to 72 classes which are very complex. In their study Wu et.al [42] depicts the method of fractal image method which is based on intelligent search for standard deviation. In comparison to the other models [43], the method is a significant improvement towards attaining significant loss in terms of reconstructed image quality.

Also, Lin et.al [44] in their study proposed a search strategy which is dependent upon the edge property, as its superior performance of the Duh' method is evident from the experimental results provided in the solutions. Zhou et.al [45] has supported in image blocks modeling based on unified feature, however the compression ratio is not so desirable in the proposed method.

In the recent past, many other methods that are based on evolutionary strategies have been proposed. To support in improving the encoding time largely some of the studies that are largely based on no search strategies [46],[47]. Wang et. al [46] has developed a no search image coding method which works on fitting plane which in comparison to Furao's method [47] and Wang method [48], the ration levels of compression, quality and encoding time appear to be very effective.

Also, the method of PSO (particle swarm optimazation) which is focused gradually has been focused upon the model. Many of the research scholars have combined upon the PSO algorithm and the fractal image compression coding methods. Tseng et.al [49] has proposed a fractal image coding method based on visual based PSO. Also in the other model by Rinaldo [50], and from Shapiro [51], it has been observed that that the self-similarity for the images is based on wavelet transform. Lin et.al [52] has also proposed a method adapting the PSO for classification based on third-level wavelet coefficients. Such methods always reduce the searching space, however, it requires huge amount of computations and the compression ratios which are small. Also, in [53], another level of speed-up technique has been introduced.

With the emergence of SDS (Suitable Domain Search) methods that are adapted, there are many methods that are adapted, for instance wide variety of techniques have been proposed for fastening the SDS and towards cumulatively addressing the Speed Techniques [54]-[72]. Such techniques include few of the significant models like block reduction techniques [54]-[63], and methods like inventive domain search techniques [64]-[72].

Duh et.al [57], has also introduced the kind of adaptive fractal coding which is relying upon DCT coefficients. The thresholds in the process has been determined an exquisite manner and the results depict that the model is very effective in terms of speedup ratio denoted as 3, however the results also depict that the encoding time is still high and the compression ratio is small. In simple terms, the objective of the studies has been about reducing the time, either by limiting the required time for SDS by reducing the time required for computation, or by addressing the issues of complexity of computation. In the recent past, many speedup techniques have been proposed on diverse approaches which came in to picture.

Jaferzadeh et.al in [20] has proposed a method of block classification acceleration mechanism for addressing the issues of FIC. In the proposed model fuzzy c-mean-clustering approach has been adapted for categorizing the image blocks and further compared such models with novel metric which is designed on discrete cosine transform coefficient. In the method reported, a speedup of 45 with 1db has been evaluated for compromising in the image quality. Using the Pearson's correlation Coefficient method, Sorting Based block classification scheme has been developed by Wang et.al [63]. It has produced the speed ratio till 10 with little loss in the image quality.

Wang Xing-Yaun et.al also has proposed the other model of swarm optimization and hybrid quad tree partition based [71] FIC technique, which has reduced the compression time to the range of 3 to 4 and there is improved levels of compression ratio, but there is significant reduction in the PSNR.

In a similar kind of study, Songlin Du et.al also has proposed a method as Quantum-Accelerated FIC system [72], in which the time consumption has been impacted by using Grover's quantum search algorithm QSA [73] [74] and on the basis of reported square –root speedup there is very little loss in the quality of the images. The framework of parallel processing which is adapted in the methods [75]-[77], for achieving High Efficiency Video Compression (HEVC). The common phenomenon of parallel processing is adapted for speed enhancement in the FIC system.

Though there is some advancement, the requirement of time turns to be a snag in the compression method adapted and deduction in terms of varied levels of computational expenses for FIC which is still an unwrapped issue that could be adapted. Such a new image features are adapting the speedup technique which is proposed to further reduce the level of compression time by focusing on reducing the amount and also the complexity towards addressing the SDS, in terms of maintaining the quality and compression ratio when compared to the BFIC method.

In the fast FIC schemes, the classification process is also applied in order to classify the domain blocks in to various classes, and each of the matching block is searched using several classes that are associated with the blocks. Despite the fact that there are many schemes that are proposed for speeding up the encoding in FIC, the time consumed is still on higher side.

In the case scenario of processing with encoding time to process a 512 × 512 image comprising 4 × 4 range blocks, the processing time as per the DRDC scheme that is proposed by Riccardo Ditasi et.al [78], could take approximately 20 seconds and for processing the 256x256 image, the processing time as per DUFC model of Yi-Ming Zhou et.al [79] shall be more than 2.8 seconds.

Despite the fact that such schemes need not be compared for analysis, without evaluating under similar test conditions, still the results depict the fact that there is significant need for increasing the speed of encoding in FIC. Also, some of the schemes like variance-based block sorting scheme that is proposed by He et al [80] and the model of Fisher's 72 classes' scheme [81] clearly denote the fact that the process is more effective in terms of encoding, but the reconstructed image quality in such schemes shall be very complex in terms of preserving them. Such conditions clearly denote the fact that FIC scheme is very essential towards speeding up the encoding in more effective ways and in terms of preserving the reconstructed image quality for better outcome.

Also in some of the studies, the researchers have proposed on varied range of color image compression techniques, and some of the key solutions pertaining to such kind of color image compression have been discussed in the following sections.

Shiping *Zhu*, Liang *Yu*, Kam IBellouata [82] in their study has proposed the method of adaptive threshold quad tree fractal compression model that has some fixed square segmentation approach with greater flexibility. It also divides the image block with high details in terms of smaller sub-block and also for the image block that has low details, which divides them in to some of the larger sub-blocks. By such a process, it is evident that the number of image blocks that are needed to match and shortening of the encoding time has to be focused upon.

Jinjiang *Li*, *Da Yuan*, *Qingsong Xies*, Ca iming *Zhang* [83] , in their study proposed a method that focus on ant algorithm for fractal compression and works on implementing the automatic classification towards an image block. In the instances of matching, it can make use of heuristic information and also the substitute global search that works with local research. In terms of comparison of average brightness for the image block and also the sub image block.

B.Hurtgen, Castile proposes the model in which the Stiler classifies the sub-block in to 15 categories, and further by focusing on sorting the image block's variance, each of the categories shall be classified in to 24 sub-classes. Hence, in total the image blocks shall be classified in to 360 categories, whilst matching the fact that the search is carried out in same category.

Pedro F. Felzenszwalband Daniel P. Huttenlocher, [84] has focused on the method of fast image segmentation algorithm which has the characteristic difference of regions and inter domains, and the inputs like how it can judge about the boundary between two regions. In comparison to the traditional image segmentation based algorithm, such model provides images that are of global visual features.

Sofia Douda, Abdallah Bagri, Amer Abdelhakim EI Imrani [85] hasproposed a new method that is developed on the basis of DCT coefficients. In such a method, the domain blocks that have low activity are always discarded from the domain pool. Also, the activity of blocks is depending on the horizontal and vertical DCT coefficients.

Ruhiat Sultana, Nisar Ahmed and Shaik Mahaboob Basha [86] in their study discussed about an advanced fractal image compression algorithm which is based on quad tree that is constructed to search attractor either from the big domain block, and if the domain block is not able to trace any similar kind of block in the range, the most similar range block shall be searched for and it estimates the correctional value towards constructing the fictitious range block.

GoharVahdati et al [87] discussed a fractal image compression method developed on the basis of spatial correlation and hybrid particle swarm optimazation along with GA. There are two significant stages in the algorithm, where the first stage focus on local optima that is used for spatial correlation between neighboring blocks, and in the instances of local optima not being satisfied, the second stage of algorithm is adapted to evaluate similarities between the whole images.

Kharate and Pail proposed that the compression ration which is adapted for and the quality which has improved considerably from the entropy adapted for enhancing the run-length towards encoding, which is predominantly on the wavelet packet best tree. Also, in the process of decomposing a tree, the method has to focus on minimization of time complexity for wavelet packet decomposition. Some of the sub bands comprising significant information on the basis of threshold entropy shall be envisaged from the implementtation of the algorithm.

D. Venkatasekhar and P. Aruna [88] has proposed an effective Genetic Algorithm, which is used for finding the best block in terms of replacement, as the fractal image is carried out very easily. In the proposed model, Genetic Algorithm comprising Huffman coding shall be used for fractal image compression. Khalil [89] has implemented a Run Length coder that is made simple and more effectively. If the proposed algorithm has worked on quantized coefficients for the DCT in several concurrent tokens get existed.

Vijaya-Prakash and Gurumurthy [90] discussed a technique which could support in improving the data compression process. A new model of DCT and Quantization architecture has been designed to address the image compression, which could be adapted by deploying the DCT. Once the compression is achieved by performing quantization for the DCT data coefficients. Yih-Lon Lin and Wen-Lin Chen [91] has proposed a method in which the swarm optimization is adopted for classification and also towards Dihedral transformation for speeding up the fractal image encoder. Using the PSO algorithm, the best match solution for the search space is adapted, and in the process, similarity measures that are essential for performing only when the domain and range blocks are considered to be same type.

Deepthi Narayan, Srikanta Murthy K., and G. Hemantha Kumar, [92] has focused upon comparing the varied kind of approaches that are prevalent for the image features, segmentation and similarity algorithm towards improving the segmentation quality. It has led to the development of weighted Euclidean distance for computing the edge weight for RGB color images and also the modification for segmentation algorithm is also carried out for identifying the prominent edges that are selected.

Hai Wang, [93] proposed an adaptive threshold quad tree fractal compression approach, in which the semantic characteristic is focused upon and the graph-based image segmentation for fractal image compression, and separating an initial image to many logic areas were focused upon, for ensuring better levels of fractal image compression.

$Zhi-liang,\ ZHAO\ \ Yu-li,\ YUHai,$ [94] detailed an effective and efficient fractal image compression model that is based on pixel distribution and triangular segmentation. However, the fractal image compression algorithm needs an effective time to complete the encoding process, and towards addressing such problem, the scope of efficient fractal image compression that is developed and proposed based on pixel distribution and triangular segmentation has been depicted.

However, exploiting the characteristics of centroid uniqueness and also in terms of focusing on the centroid position that is invariance towards a particular discrete system, along with matching amid of the range blocks and the domain blocks has been implemented. In addition to such developments, even the original images that are processed to equilateral triangle segmentation shall reduce the volume of domain blocks and also raise the efficiency of fractal coding.

YuliZhao, Zhi-liang Zhu, Hai Yu [95], also has proposed another fractal color image coding algorithm, which focus on correlation between RGB components and also the equilateral triangle based segmentation is presented, rather than focusing on square segmentation to offer improved efficiency.

FFT based fractal image coding is proposed in [96] by Hannes, for speeding up the encoding computations. The collage error towards addressing the range and domain range is measured on the basis of five different inner product operations. Every inner product implementation adapts FTT based cross correlation operation. In terms of quantized gray level transformation (s and o) there are numerous parameters that are considered for calculating the domain block for determining the collage error. In [97], the mean subtracted normalized cross correlation for FTT is presented in [97], which could support in evaluating similarity range and domain block.

Computation of energies towards mean subtracted or overlapped domain blocks are intense in terms of computation. Among the fractal image coding point of view, there are many single computation of domain image which is required for addressing all the range blocks. But in the case of frame based fractal video coding search area towards addressing all range blocks which could be very different and shall be overlapped with any other search areas

In [98], an effective model using cross-hexagon search (NHEXS) has been proposed for fractal video coding, to address the higher motion in terms of speed used for searching stationery and also for searching in quasi stationery blocks. In the first stages, it adapts search patterns that are of two cross shaped are adapted and accordingly some of the large/small hexagon-shaped patterns that comply with NHEXS towards halfway stop technique is developed, and using the modified partial distortion criterion (MPDC) for minimizing the encoding time the process is carried out. In extension to the model of NHEXS, another study [99] proposes the video sequences that are encoded by region-based approach. In the method the regions are defined as per the earlier computed segmentation map and the ones that are encoded independently for each other. Object based stereo of video compression on the basis of combinations for the shape-adaptive DCT and fractals are developed in [100]. In [101], the study has focused on models for compressing the mobile videos using fractal, where the genetic algorithm and particle swarm optimization techniques are adapted for improving the quality of video and speed up factor respectively.

To address the issues of some of low bit rate videos, effective methods like inter cube correlation search that has spatial and spatial-temporal directions are presented in [102] for the purpose of improving the coding performance. Motion and non-motion wavelet sub trees for each of the inter frame are coded independently by focusing on fractal variable tree towards set partitioning algorithm [103], [104] that has suitable low bit rate videos.

III. Conclusion

Review of extensive literature pertaining to how the fractal image solutions have been developed, applied in to various levels of image compression solutions, clearly indicate the fact that despite of significant developments that are taking place in the solution, there are significant challenges that are envisaged. It is imperative from the study, despite the fact that there are many studies in place related to decreasing the coding time and improving the quality of compression, and decoding, still there are numerous factors that are turning out to be major challenges that has to be addressed.

In lieu of the emerging scenarios, where thousands of images are generated in an hour and millions of images are transacted between the users, and being corresponded between the systems, the need for compression is very high, and fractal compression images model being and an effective solution, there is significant need for extensive research in terms of addressing the short comings that are envisaged in the process for improving the efficiency and performance of FCI.

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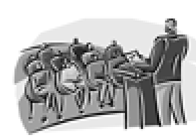

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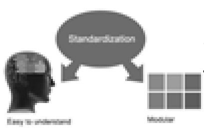

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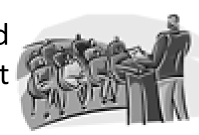

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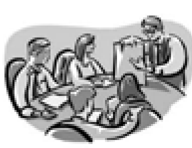

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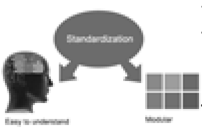

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Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

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All manuscripts submitted to Global Journals Inc. (US), ought to include:

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Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

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Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

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11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

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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.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

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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.

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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

· Use standard writing style including articles ("a", "the," etc.)

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

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

· Align the primary line of each section

· 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.

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- 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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- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- 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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- 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.

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- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
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- Resources and methods are not a set of information.
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- Leave out information that is immaterial to a third party.

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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.
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- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
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Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
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- Give details all of your remarks as much as possible, focus on mechanisms.
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- 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?
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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
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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