A NEW BLOCK TRUNCATION CODING (NBTC) FOR SATELLITE IMAGE RETRIEVAL USING DOT-DIFFUSION TECHNIQUE

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Abstract- Presently there are issues related to retrieval of satellite images from huge database wherein the data goes on mushrooming day by day .The low bit rate configuration are causing problems such as noise, inherent artefact .Therefore to overcome these issues a new block truncation coding using dot diffusion technique is proposed in this paper. The dot diffusion technique has the characteristic of parallelism in order to enhance the processing efficiency. Here to retrieve the best quality image the class and diffused matrix is used of size 16 × 16 . On studying and comparing the results with Block truncation coding technique using error –diffusion and the proposed new block truncation coding using dot diffusion the results show that the proposed system gives excellent image quality ,high performance . It also satisfies one of the vital the processing efficiency attribute.

Keywords: Satellite image retrieval (SIR), Block Truncation Coding (BTC), Dot Diffusion, image database , New Block Truncation Coding (NBTC)

I. INTRODUCTION

Delp and Mitchell the founders of Block Truncation Coding. They discovered it in the year 1979.The Block Truncation Coding (BTC) is a lossy technique which is used for image compression for decades[1]. But eventually it is used for image retrieval also. Although there are many advanced technologies such as JPEG, JPEG 2000 but the BTC technique is outstanding of all. The flow of the technique is such as: First of all the query image is divided into number of blocks that are non overlapped to each other. Secondly, the Mean and Standard Deviation are obtained. Thirdly, a threshold is fixed and applied. Lastly, if a pixel value is greater than or equal to that of the considered threshold that pixel will have a corresponding pixel position '1' in the bitmap otherwise it will have '0'.

This paper focuses strictly on satellite image retrieval using DDBTC for processing and dot diffusion technique at relevance feedback. Here a benchmark of 1000 satellite images are used .Where images are of different category like coastal, forest, metro and desert region. The result can be retrieved by using features like color and texture .Both these features achieve almost 95% of efficiency, reliability and specificity.

The rest of the paper is organized as follows: Section II explains the related work done. Section III Dot Diffusion Algorithm Section IV describes the Proposed New Block Truncation Coding. At last, Section V shows experimental results and Section VI draws towards conclusion

II. RELATED WORK

On studying the previous research it is found that many approaches have been implemented to improve the BTC. D.R.Halverson, N.C.Griswold and G.L.Wise [2] describes a technique of preserving moment features of the original image .Here the authors describe that a group of moment preserving quantizes are employed to moments those are higher than three. Q.Kanafani, A.Beghdadi and C.Fookes [3] addresses an image is decomposed first into non homogenous and homogenous blocks .Then it is BTC compression technique is applied .Here the good image quality is obtained. The block classification is attained by image segmentation theory associated with expectation – maximization (EM) algorithm. There lies some complexity even though improvements are carried on.

Recently researchers have found some half toning based BTC theories in improvisation of quality of result images and minimization of computational complexity. J.M.Guo[4] described error diffusion in order to maintain the local average tone the diffusion of quantized errors to neighboring pixels in bitmap is taken place by a technique

called error-diffused BTC (ED-BTC).The technique lacks the property of parallelism because half toning does not support parallelism. It is also a time consuming task .Thus to overcome this issue J.M.Guo and M.F.Wu researched the ordered dither (BTC). Here, the processing efficiency is improved by applying look up table dither arrays. It gives a lowest quality of image that is blurred in appearance. Thus, there lies an issue relating to false contour and artifacts.

Not only processing an image is an problem but also retrieval of image is also a concern. Many approaches have been found in order to retrieve the best relevant image matched to that of the query image. The major concern lies in reduction of the semantic gap.

Authors M. Mese and P. P. Vaidyanathan, described Optimized half toning using dot diffusion and methods for inverse half toning [5].They have incorporated BTC to yield the proposed dot-diffused BTC (DDBTC) technique. Here diffused matrix and class matrix are co-optimized to obtain even better image quality as compared to that of EDBTC, Also has maintained the parallelism similar to that of ODBTC. These two characteristics describe the proposed DDBTC can be efficient compression applications and low power systems, e.g., low end embedded systems or handheld devices for image/video recording. Thus, the proposed method can be considered as a powerful technique for to use in most of the low power image/video codec system.

Authors H.B. Kekre, S.D. Thepade et al. have described Image Retrieval with Shape Features extracted using Gradient Operators and Slope Magnitude technique with BTC [6]. They have considered generic image dataset of 1000 images of 11 different categories and tested it. The performance analysis is studied upon the average precision and recall computed of all queries. Mask Shape type of BTC technique is used but it has limitation is that the query image and database image should be of the same size. Also, Gradient Operator is used for shape feature extraction .Operators like Prewitt, Robert, Sobel and Canny are used.

Authors Y.N.Mamatha and A.G Ananth have described CBIR of Satellite Imageries using Soft Query Based Colour Composite Technique [7].They suggested that colour can be used as content. Therefore, content based image processing was carried out for sample dataset of satellite images consisting of urban image of high resolution and rural image of low resolution.

Authors Yu-f-x, Luo, H, Lu, Z-m have described Colour image retrieval using pattern co-occurrence matrices based on BTC and Vector Quantization[8].They suggested each colour image input is decomposed into Y, Cb and Cr components and then the BTC technique is applied to the 4×4 Y blocks. The pair of mean sequence and also the bit plane sequence are quantised with the contrast pattern codebook and visual pattern codebook in order to obtain the contrast and visual pattern co-occurrence matrix. Vector Quantization is applied to 4×4 Cb blocks and Cr blocks with the Cb codebook and Cr codebook respectively. Thus colour pattern co-occurrence matrices are obtained. The Retrieval simulation results, compared with two existing BTC-based features, highly improve retrieval efficiency.

Authors H.B. Kekre, S.D. Thepade have described Image Retrieval using Augmented Block Truncation Coding Techniques [9]. They suggested the Binary truncation coding that is based on the colour features of the CBIR methods of the image. This approach considers red, green and blue planes of image together in order to compute the feature vector. Also augmentation has been done on the BTC based CBIR as BTC-RGB and Spatial BTC-RGB. In the BTC-RGB the feature vector is computed by considering red, green and blue planes of the image independently. Whereas that in Spatial BTC-RGB the feature vector is composed of four blocks. Each block is representing the features extracted from one of the four non overlapping quadrants of the image. This method is tested on the 1000 images database and the results describe that the precession is improved in BTC-RGB and is even better in Spatial BTC-RGB.

III. DOT DIFFUSION BLOCK TRUNCATION CODING (DDBTC)

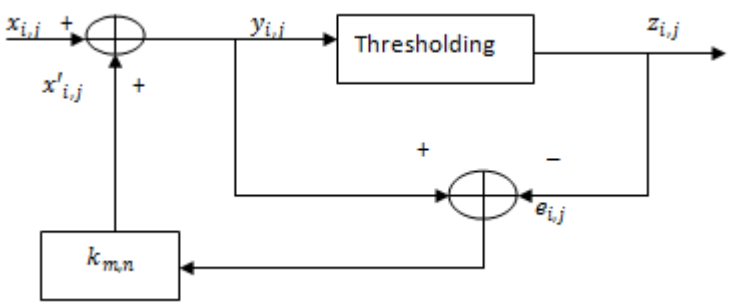


Fig 1. Representation of Dot Diffusion

Basically Dot Diffusion is one of the methods of half toning.Half toning is generally used in improvization of image quality, clearity etc.The reason to incorporate Dot diffusion is that it possess the property of parallelism[10] The DDBTC technique is used in this research where coloured satellite images are converted into gray scale after resizing then applying BTC on it extracting Low mean and High mean .
The technique is explained below:

The query image of size A × B is first partitioned into fixed sized many non-overlapped blocks say R×S .To specify ,each of the non-overlapped blocks are not dependent on each other.Those blocks of images are then represented by two standard terms say ,mean and standard deviation equation (1),(2).

$$\bar{p} = \frac{1}{R\times S}\sum_{i=1}^{A}\sum_{j=1}^{B} p_{i,j} \qquad (1)$$

$$\overline{p^2} = \frac{1}{R\times S}\sum_{i=1}^{A}\sum_{j=1}^{B} {p_{i,j}}^2 \qquad (2)$$

The variance corresponding to it is calculated as ; where $\bar{p}$ is threhold

$$\sigma^2 = \overline{p^2} - \left(\overline{p^2}\right) \qquad (3)$$

From the above Equation we learn that ;

$p_{i,j}$ is a variable that denotes the gray scale value of pixel in the block of image.

The high mean and the low mean are calculated by equations (4) (5) respectively ;

$$d = \bar{p} - \sigma\sqrt{\frac{q}{m-q}} \qquad (4)$$

$$c = \bar{p} + \sigma\sqrt{\frac{m-q}{q}} \qquad (5)$$

$$p_{max} = \max(W) \qquad (6)$$

$$p_{\min} = \min(W) \qquad (7)$$

Here , vector W denotes the original divided image block .Equation (6) and (7) denotes local maxima and minima respectively.here each of the block is processed independently and its processing order of pixels is eplained by class matrix.The class matrix is mapped to each divided block wherein the processing starts with the pixels associated to number '0' .Thus ,the processing method is represented in equation (8) and (9) ;

$$y_{i,j} = p_{i,j} + {p'}_{i,j} \qquad (8)$$

Where ,${p'}_{i,j} = \sum_{(m,n\in R)} \frac{e_{i+m,j+n}\times k_{m,n}}{sum}$

$$e_{i,j} = y_{i,j} - z_{i,j} \qquad (9)$$

Where, $z_{i,j} = \begin{cases} 0 & if\ y_{i,j} < 128 \\ 255\ if\ y_{i,j} \geq 128 \end{cases}$

Where ,variable $p_{i,j}$ denotes the grayscale current input value ,variable ${p'}_{i,j}$ denotes the diffused error that accumulated from processed neighbouring pixels and variable $y_{i,j}$ denotes gray scale modified output . The $z_{i,j}$ denotes the binary bitmap output ,variable $e_{i,j}$ denotes the difference between modified grayscale output and binary output. The variable $k_{m,n}$ denotes the diffused weighting and R denotes the surrounding region of support for the diffused weighting .The diffused weighting is represented as [10]

$$\begin{bmatrix} k_{-1,-1} & k_{-1,0} & k_{-1,1} \\ k_{0,-1} & x & k_{0,1} \\ k_{1,-1} & k_{1,0} & k_{1,1} \end{bmatrix}$$

The variable x denotes the current position of pixel that is processed.Specifically the error can be diffused only to the neighbouring pixels that is associated to the numbers in class matrix .These pixels are supposed to be thresholded .The variable sum is the summation of diffused weights that corresponds to the unprocessed pixels as shown in equation (10)

$$\text{Sum} = \sum_{m=-1}^{1}\sum_{n=-1}^{1} \begin{cases} k_{m,n}, if\ c_{i+m,j+n} > c_{i,j} \\ 0, if\ c_{i+m,j+n} < c_{i,j} \end{cases} \qquad (10)$$

The Class matrix and Diffused matrix used as proposed by Jing-Ming Guo and Yun-Fu Liu [1].Here the $c_{i,j}$ denotes the co-efficient value in the class matrix.

51	54	60	20	28
43	56	55	19	33
59	41	34	12	62
13	11	2	42	47
22	9	50	61	57

Fig.2 Example of Diffusion that takes place between the blocks by using class matrix

Fig .2 is demonstration that is explains how the diffusion is taking place **.** As shown above there are 4 regions of different colour. Colour is given to image for presentation purpose only. Here the central position is where the number 34 is located currently .The position is called as current processing position .Here on observation the circled position shows that they are already processed pixels. The arrows indicate the directions possible for diffusion. Thus, the pixels less than 34 are processed so now 4 are the number of direction possible for diffusing. Therefore, the variable sum $=k_{-1,-1}+k_{-1,0}+k_{0,-1}+k_{1,1}$ from Fig. 2. The error can diffuse to self block as well as to the neighbouring blocks.

Thus, the equation (9) is modified as $e_{i,j} = y_{i,j} - z_{i,j}$, where $z_{i,j} = \begin{cases} p_{min,} & if\, y_{i,j} < \bar{p} \\ p_{max,} & if\, y_{i,j} \geq \bar{p}' \end{cases}$ (11)

IV. PROPOSED A NEW BLOCK TRUNCATION CODING

Initially the BTC technique was studied and it explained the flow of the system as follows: Query image was divided into several non overlapped blocks then the mean and the standard deviation was calculated as that of Traditional BTC.That means here the gray scale of images was considered for the entire system result.BTC is also known as 1-bit quantizer with a certain threshold .The threshold is used to binarize the block. Then the bit map is obtained and again the resultant image is reconstructed. it concludes that the traditional /primitive BTC is used to preserve the first moments of block and second moments of block where the original image is substituted by the obtained high and low means .

The proposed new block truncation coding (BTC) for satellite image retrieval using dot-diffusion technique is slightly similar to DDBTC.

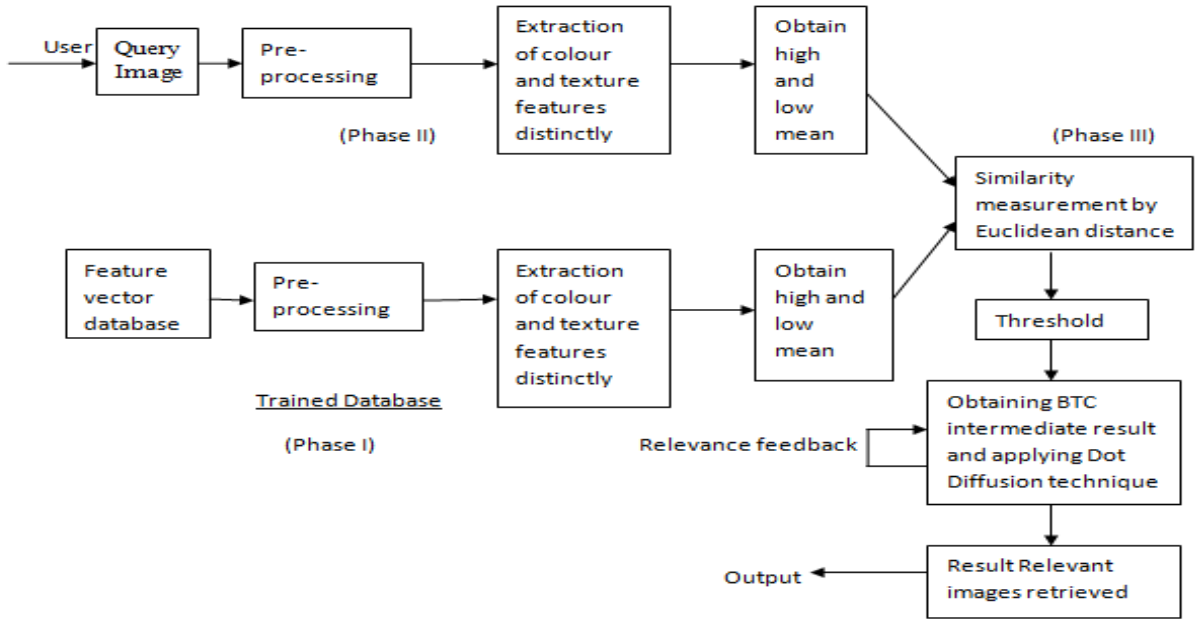


Figure.3 Architecture of proposed new block truncation coding (BTC) for satellite image retrieval using dot-diffusion technique

The above Fig.1displays that system works in total three phase's .The three phases such as:

1. Creation of trained database of 1000 satellite images.

2. Extraction of Color and texture features separately and applying BTC
3. Lastly, the similarity measurement and applying relevance feedback by dot diffusion (DDBTC)

Phase I:

In this phase the satellite images are pre- processed that means here the images are resized and converted into gray scale on where their features of colour and textures are obtained. The colour feature is extracted by using colour moments, HSV histogram and auto correlogram whereas the texture features are extracted by Gabor wavelet where mean Amplitude, msEnergy and wavelet moments are calculated. Then, after extraction of features color and texture the high mean and the low mean are obtained by the use of BTC.

Phase II:

Here, if a user expects relevant images to be retrieved by colour feature. The query image will be first of all pre-processed .Then; the database is automatically loaded with the query image features. Similarly is the processing schema for extraction of texture features .Here it depends on the user whether user desires to have result based on colour or texture features .

Phase III:

Lastly the similarity measurement is done on basis of Euclidean's distance .A certain threshold is applied in order to retrieve the best matched images against the query image. Here, the BTC colored images are obtained and Dot Diffusion technique is applied for relevance feedback. The retrieved images display dot diffused images and then the final output is color DDBTC image.

Thus, is the system over-view of proposed new block truncation coding (BTC) for satellite image retrieval using dot-diffusion technique.

Feature extraction

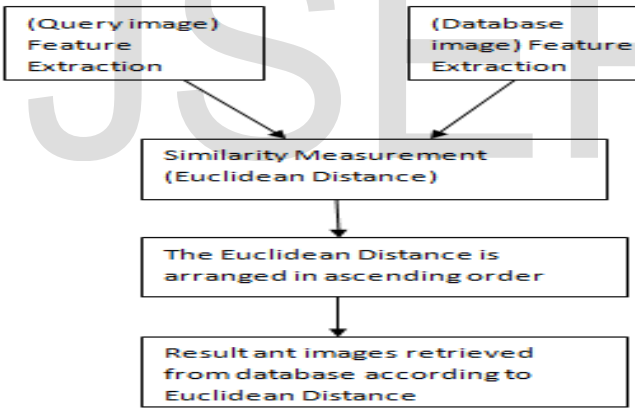


Figure.4 Feature extraction of proposed new block truncation coding (BTC) for satellite image retrieval using dot-diffusion technique

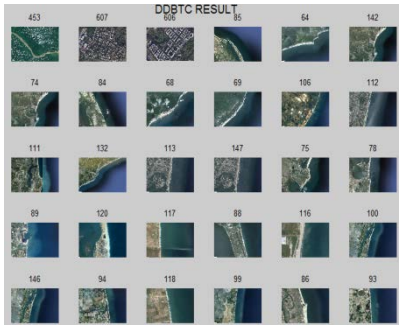
Here the Similarity Measurement is selected on terms of how close a vector is to other vector. This paper examines the Euclidean's Distance for calculating the similarity distance. The most minimum distance is taken into consideration. On that basis the images in the result are obtained.

V. EXPERIMENTAL RESULTS

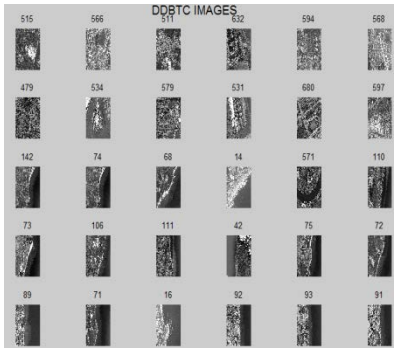
The proposed new block truncation coding (BTC) for satellite image retrieval using dot-diffusion technique is generally carried out from the operating system associated with MATLAB (version 7. 12) altogether with hardware setting as i) Processor: Intel core i3, ii) CPU Speed: 3.20 GHz, iii) OS: Windows 7 and iv) RAM: 4GB and satellite image dataset from NASA Laboratory. The following fig.5 displays the result of coastal, desert, forest and metro region respectively.

(i)

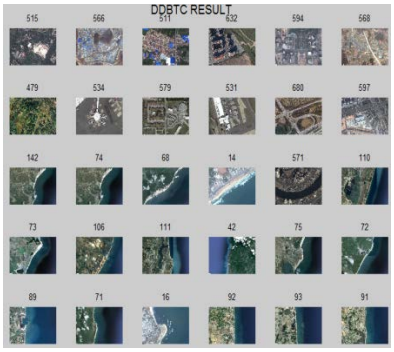
(ii)



(iii)

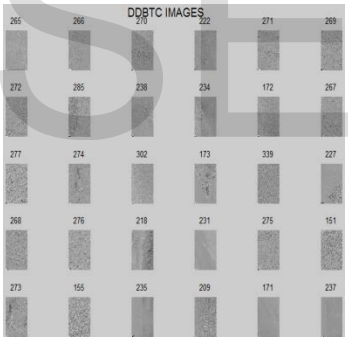


(iv)

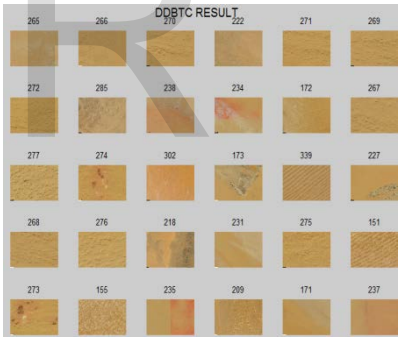


(v)

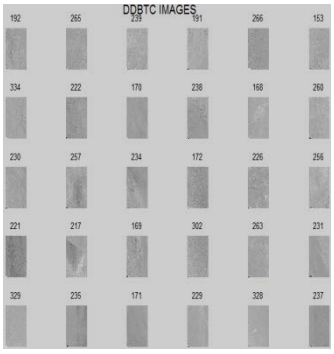
(i)



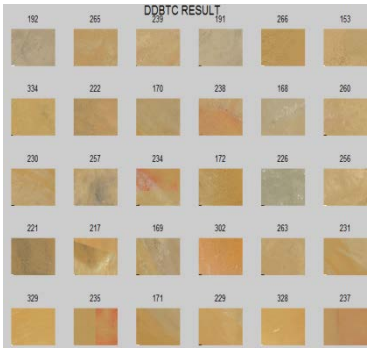
(ii)



(iii)



(iv)



(v)

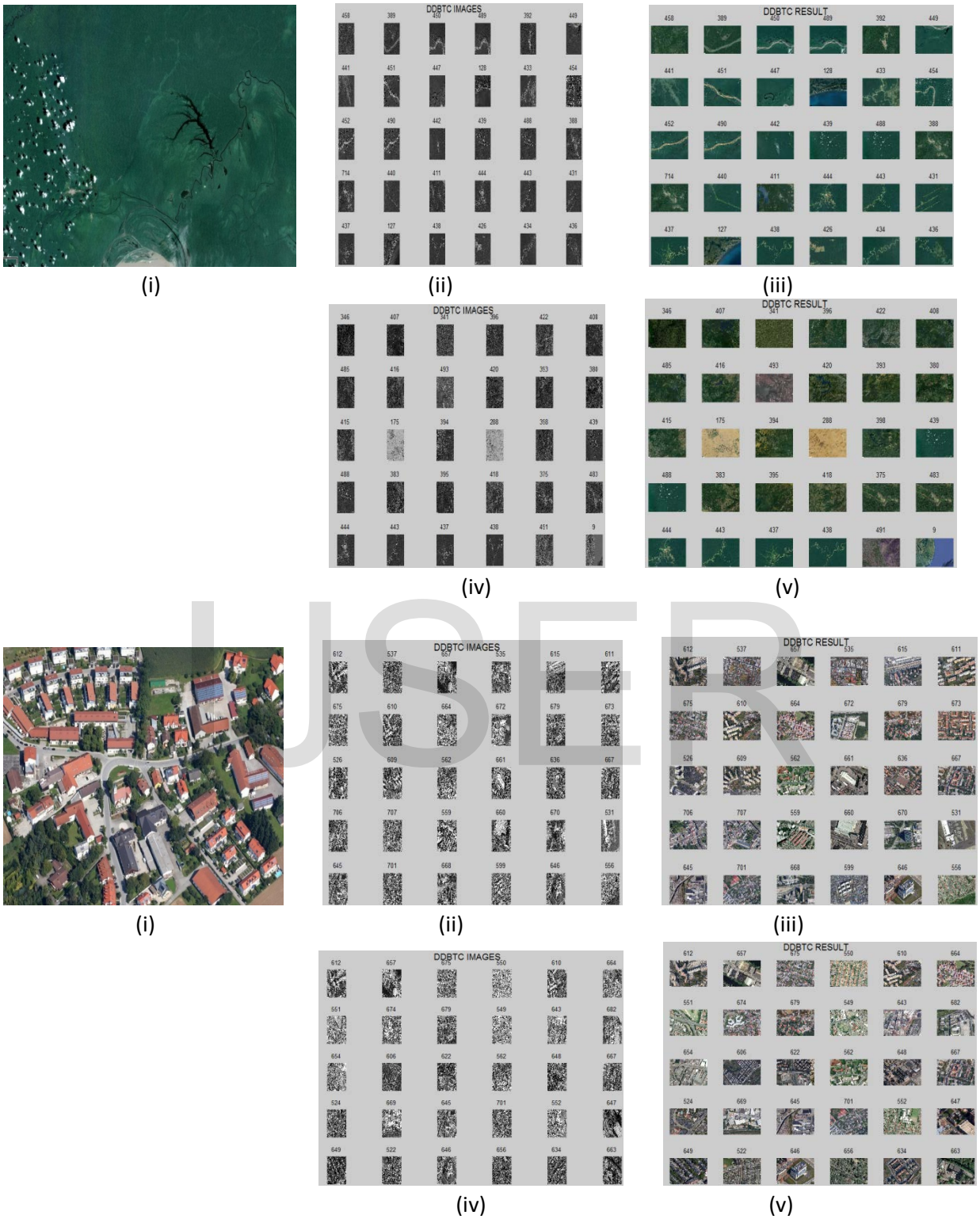


Fig. 5 (i)-Query Image ,(ii)-Dot diffusion image by color feature(gray scale),(iii)- Result image by color feature, (iv)- Dot diffusion image by texture feature(gray scale),(v)- Result image by texture feature

Performance Analysis:

In this work, we have considered the actual databases of 1000 satellite images.The performance of the system is calculated by Precision and Recall**.** The Fig.6 displays the values of precision and recall respectively whereas Fig.7 shows its corresponding graph**.**

Precision = (images those are retrieved) ∩ (images those are relevant) / (images those are retrieved) (12)

Recall = (images those are retrieved) ∩ (images those are relevant) / (images those are relevant) (13)

Query Images	NBTC	
	Precision	Recall
COASTAL	92.79	95.45
DESERT	96.98	95.21
FOREST	98.5	95.13
METRO	92.1	94.10

Fig. 6 Precision and Recall table performance

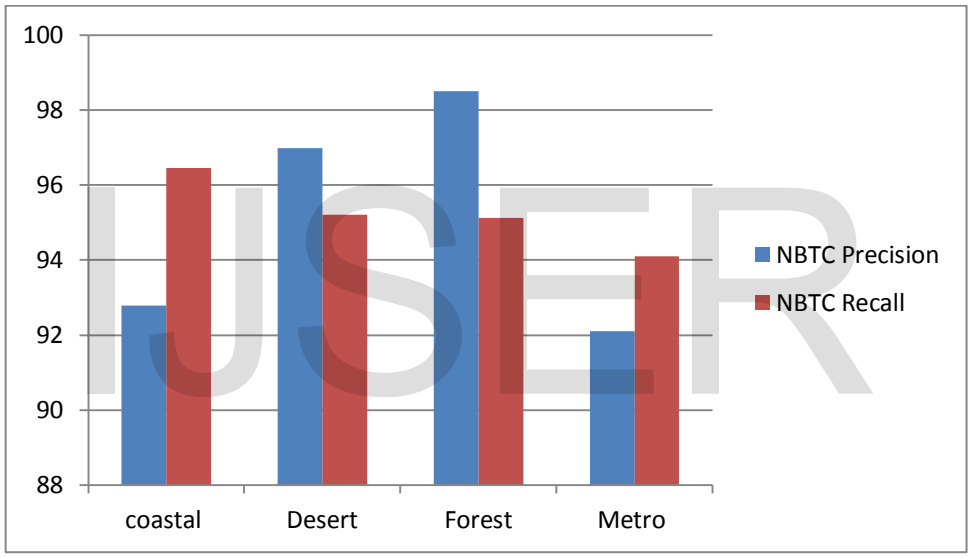


Fig.7 Precision and Recall graph

Discussion: The proposed technique (NBTC) is applied to all the 4 regions coastal, desert, forest and metro. Here, for some query images 99.99% of relevant images are obtained but that of some query images give some non relevant images are retrieved.The system gives 92%,93%,92.51% of reliability ,specificity ,sensitivity respectively. Thus, from above graph Fig. 7 we see that forest region precision is the highest while that of coastal region recall is high .

VI. CONCLUSION

This paper presented a new block truncation coding with dot diffusion at relevance feedback attained the best quality image. The technique of dot diffusion has inherent properties of parallelism which is one of the advantages. The class and diffused matrix reduced the complexity of processing the image. On comparison Dot Diffusion technique yields far much better image quality as that of Error Diffusion.Thus, the proposed system is highly efficient. The system is not only efficient but also has less complexity. The system gives result satisfactorily. The future research work can be done using Feature vector by merging two or more image features like shape, colour and texture and applying the whole process as described above.

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