Content Based Image Retrieval using Density Distribution and Mean of Binary Patterns of Walsh Transformed Color Images

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Abstract- This paper introduces a novel idea of Binary Pattern observation of column wise and Row wise Walsh transformed color images for feature vector generation. The density distribution of Sal, Cal components of Binary Pattern and its mean values are considered as two different approaches for the same. The proposed method experimented with and without augmentation of average of zeroth Cal and average of last Sal components in the Feature vector. This paper discusses use of Euclidian distance and sum of absolute difference as similarity measures in each of the approaches as mentioned above to check the retrieval performance. The work is experimented on image database of size 1055 images containing 12 classes. Two new parameters of performance measuring parameters i.e. LIRS and LSRR are introduced apart from precision and recall which are very general.

Keywords- CBIR, Binary Pattern, Euclidian Distance, Sum of Absolute Difference, LIRS, LSRR, Precision and Recall.

I. INTRODUCTION

Content-based image retrieval (CBIR), [1][2] is any technology that in principle helps to organize digital picture archives by their visual content. By this definition, anything ranging from an image similarity function to a robust image annotation engine falls under CBIR. This characterization of CBIR as a field of study places it at a unique juncture within the scientific community. It is believed that the current state-of-the-art in CBIR holds enough promise and maturity to be useful for real-world applications if aggressive attempts are made. For example, many commercial organizations are working on image retrieval despite the fact that robust text understanding is still an open problem. Of late, there is renewed interest in the media about potential real-world applications like finger print recognition, pattern matching [3-4][14-15] of CBIR and image analysis technologies, There are various approaches which have been experimented to generate the efficient algorithm[9-13] for CBIR like FFT sectors [5-8], Transforms [16][17], Vector quantization[16], bit truncation coding, row mean and column mean [17-19]. In this paper we have introduced a novel concept of calculating the density distribution and mean of Binary Patterns in both column wise and row wise Walsh transformed color images for feature extraction (FE).Two different similarity measures namely sum of absolute difference and Euclidean distance are considered. The performances of these approaches are compared.

II. WALSH TRANSFORM

A complete binary orthogonal set of functions was developed by Walsh [21].A sample version of these functions is known as Walsh transform. Walsh transform matrix is of the order of 2^n .Walsh transform of size 8x8 is given below.

W(m,n)=

1	1	1	1	1	1	1	1
1	1	1	1	-1	-1	-1	-1
1	1	-1	-1	-1	-1	1	1
1	1	-1	-1	1	1	-1	-1
1	-1	-1	1	1	-1	-1	1
1	-1	-1	1	-1	1	1	-1
1	-1	1	-1	-1	1	-1	1
1	-1	1	-1	1	-1	1	-1

Advantages of the Walsh transform [10-13][20]: Real, No Multiplication is required. Some properties are similar to those of the DFT Forward and inverse Walsh transforms are similar.

Forward: $F(m) = \sum f(n)\, W(m,n)$ (1)

Inverse: $f(m) = 1/N \sum W(m,n)\, F(n)$ (2)

Where n varies from 0 to N-1

III.PROPOSED METHOD

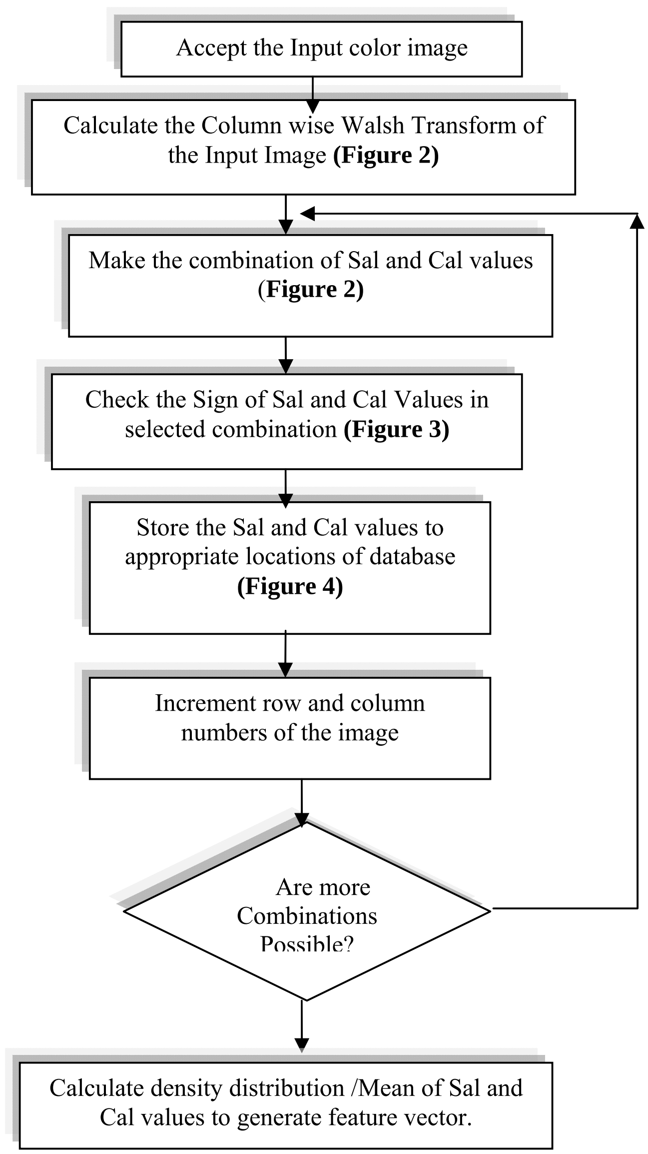

Figure 1: Flow chart of proposed Method

The flow chart shown in the Figure 1 depicts the steps of proposed method for feature vector generation using the Binary Pattern of the color image. Figure 2 depicts the Column wise Walsh transformed image which is used to get the binary pattern out of it. The average of zeroth row and the last row (yellow shade) used to generate two extra component (for each color plane i.e. R,G and B)of augmentation to the feature vector. The combinations of four components of this transformed image i.e. Sal1,Sal2, Cal1 and Cal2 are considered successively to generate the database of binary Patterns. For instance the first combination as bordered with blue color in the Figure 2 is extracted and the sign of Sal1, Sal2 and Cal1,Cal2 are checked to get 16 binary patterns.

1	2	.	.	n-1	n	
Cal	Cal	Cal	Cal	Cal	Cal	0
Sal1	Sal2	Sal	Sal	Sal	Sal	1
Cal2	Cal1	Cal	Cal	Cal	Cal	2
Sal	Sal	Sal	Sal	Sal	Sal	3
Cal	Cal	Cal	Cal	Cal	Cal	4
Sal	Sal	Sal	Sal	Sal	Sal	.
Cal	Cal	Cal	Cal	Cal	Cal	.
Sal	Sal	Sal	Sal	Sal	Sal	.
Cal	Cal	Cal	Cal	Cal	Cal	n-1
Sal	Sal	Sal	Sal	Sal	Sal	n

Sal1	Sal2
Cal2	Cal1

Figure 2: Combination of Sal and Cal components

Sign of Sal	Sign of Cal
Sal1<0 & Sal2<0	**Cal1**<0 & **Cal2**<0
Sal1<0 & Sal2>=0	**Cal1**<0 & **Cal2**>0
Sal1>=0 & Sal2<0	**Cal1**>=0 & **Cal2**<0
Sal1>=0 & Sal2>0	**Cal1**>=0 & **Cal2**>0

Figure 3: Sign check of Sal and Cal components

Consider an example if the first combination of Sal and Cal values as shown in the Figure 2 carry the sign change as Sal1>=0 & Sal2>0 and **Cal1**>=0 & **Cal2**>0 then the entry of this combination will be the 15th column in the binary pattern database as shown in the Figure 4 below: The database of binary pattern as shown in the Figure 4 shows column wise arrangement of Sal1, Sal2, Cal1 and Cal2 values of the combination decided earlier (Figure2) based on their sign change (Figure 3).The first row in this table depicts the column number which has range from 0-15 i.e. 16 Columns. The second row of the table shows the combination of the sign of Sal1,Sal2, Cal1 and Cal2.If all components i.e Sal1,Sal2,Cal1 and Cal2 are with negative sign then that is stored in the 0th column whereas if they are all positive then it finds last column position in the database.

15				……..	**1**				**0**			
+	+	+	+		-	-	-	+	-	-	-	-
Sal1	Sal2	Cal1	Cal2	……….	Sal	Sal	Cal	Cal	Sal	Sal	Cal	Cal
				…….								

Figure 4: The Binary Pattern database

These all steps are repeated for all possible combinations of Sal and Cal in the fashion discussed. At last the density distribution of these patterns in the pattern database and mean of it are taken as two separate approaches to generate the feature vector. For the mean of the density of binary pattern with augmentation of two extra component of each color plane ; the size of feature vector goes to 198(64x3color planes + 6 Augmented components) components while with only density distribution the size is 54 (16x3 color planes + 6 Augmented components).

IV. RESULTS AND DISCUSSION

We have used the augmented Wang image database[2] The sample Images of the database of 1055 images of 12 different classes such as Flower, Sunset, Barbie, Tribal, Puppy, Cartoon, Elephant, Dinosaur, Bus, Parrots, Scenery, Beach is shown in the Figure 4.

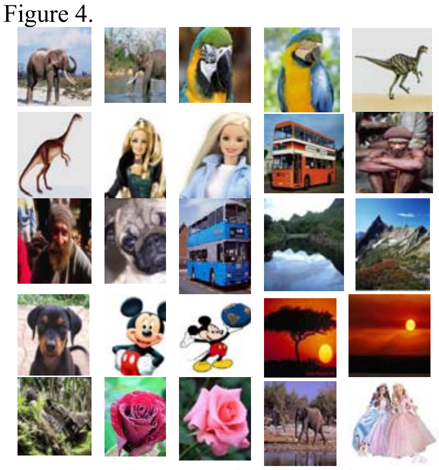

Figure5. Sample Image Database

Figure6. Query Image

The Figure 6 shows the query image of the class dinosaur. For this query image the result of retrieval of both Column wise and Row wise Walsh transformed binary pattern are checked. The Figure 7 shows the first 20 retrieval for the query image with respect to column wise Walsh transform with sum of absolute difference as similarity measure whereas the Row wise Walsh transform results are shown in Figure 8. It can be observed that the retrieval of first 20 images are of relevant class i.e. dinosaur; there are no irrelevant images till 41 retrievals in both cases. The result of row wise Walsh transformed images the retrieval rate is same except the order of retrieval of images changes.

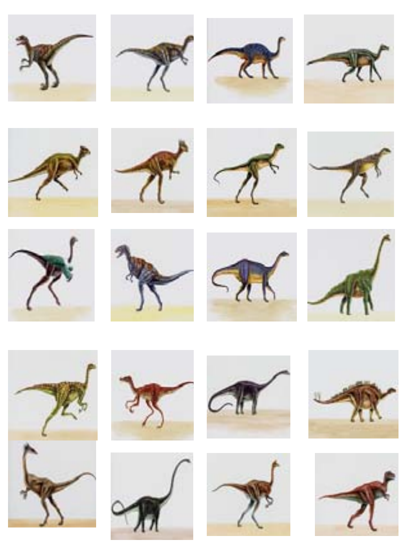

Figure 7: First 20 Retrieved Images of Column wise Walsh transform binary patterns with augmentation of average value of zeroeth and highest row components with sum of Absolute Difference as similarity measures for the query image

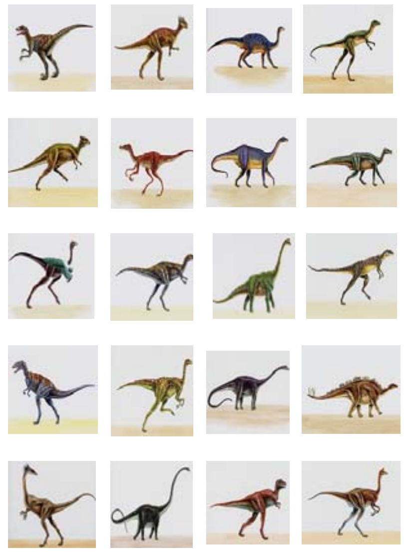

Figure 8: First 20 Retrieved Images of Row wise Walsh transform binary patterns with augmentation of average value of zeroeth and highest row components with sum of Absolute Difference as similarity measures for the query.

Once the feature vector is generated for all images in the database a feature database is created. A query image of each class is produced to search the database. The image with exact match gives minimum absolute difference and Euclidian distance. To check the effectiveness of the work and its performance with respect to retrieval of the images we have calculated the precision and recall as given in Equations (3) and (4) below. Two new parameters i.e. LIRS (Length of initial relevant string) and LSRR(Length of string to recover all relevant images) are introduced as shown in Equations (5) and (6).

$$\text{Precision} = \frac{\text{Number of Relevant images Retrieved}}{\text{Total Number of Images Retrieved}} \quad (3)$$

$$\text{Recall} = \frac{\text{Number of Relevant Images Retrieved}}{\text{Total Number of Relevant Images in the Database}} \quad (4)$$

$$\text{LIRS} = \frac{\text{Length of Initial Relevant string of Images}}{\text{Total Relevant Images Retrieved}} \quad (5)$$

$$\text{LSRR} = \frac{\text{Length of String to Recover all Relevant Images}}{\text{Total Images in the Datebase}} \quad (6)$$

All these parameters lie between 0-1 hence they can be expressed in terms of percentages. The newly introduced parameters give the better performance for higher value of LIRS and Lower value of LSRR [8-13].

The average precision and recall cross over point of binary pattern observation in Column wise and Row wise Walsh transformed images has been plotted to check the performance of the algorithm. The Figure 9 and Figure 10 focuses on the performance of the both approaches of feature vector generation i.e. density distribution of binary pattern in the database and mean of binary pattern with augmentation of extra components with respect to both similarity measuring parameters namely Euclidian distance (ED) and sum of absolute difference (AD)[8-13]. As it can be seen from that figure that average precision and recall cross over points for all class of images are varying based on the method used. The Diana sour class of image specifically gives far better result in all methods followed.

The Figure 11 and Figure 12 shows the algorithm performance with respect to LIRS plot in column wise and Row wise Walsh transformed method. Figure 13 and Figure 14 focuses on the image class wise retrieval performance of the proposed method with respect to the new parameter of performance evaluation i.e. LSRR .For the better performance of the algorithm LIRS must be maximum LSRR must be lesser as it can be seen in the case of Diana sours, flowers, sunsets etc. class of images wherein LSRR is very minimum in Binary pattern mean with ED and AD both and LIRS is more . This can be seen in Figure 11 – Figure 14.

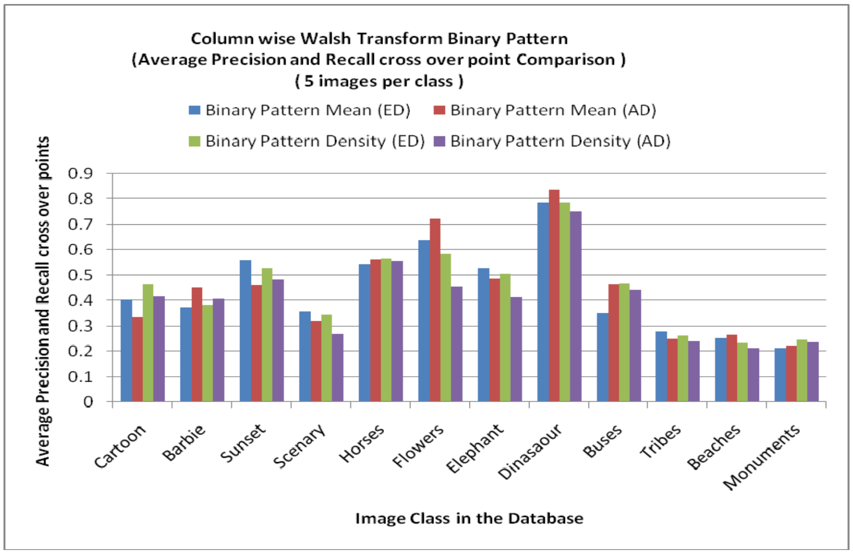

Figure 9: Comparison of Overall Precision and Recall cross over points of all class of images with Augmentation and Absolute Difference (AD) and Euclidean Distance (ED) as similarity measure.

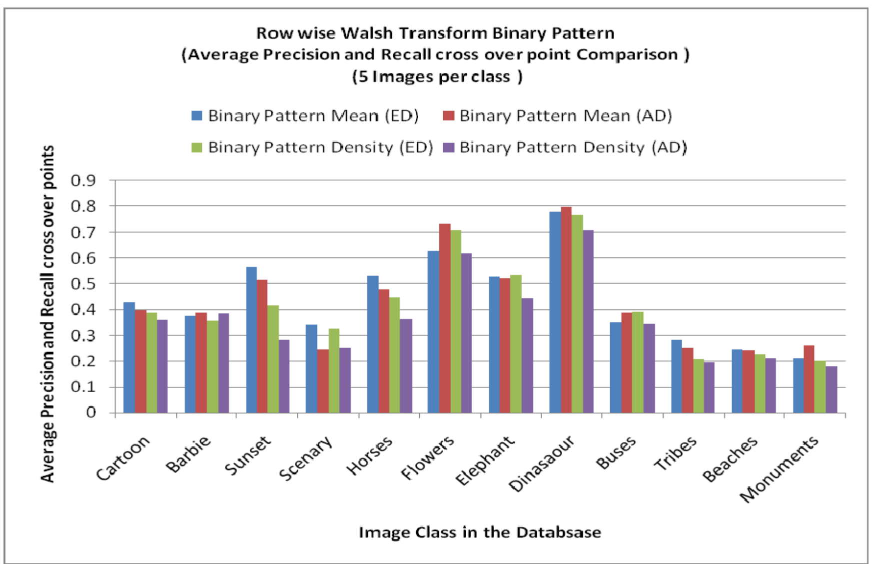

Figure 10: Comparison of Overall Precision and Recall cross over points of all class of images with Augmentation and Absolute Difference (AD) and Euclidean Distance (ED) as similarity measure.

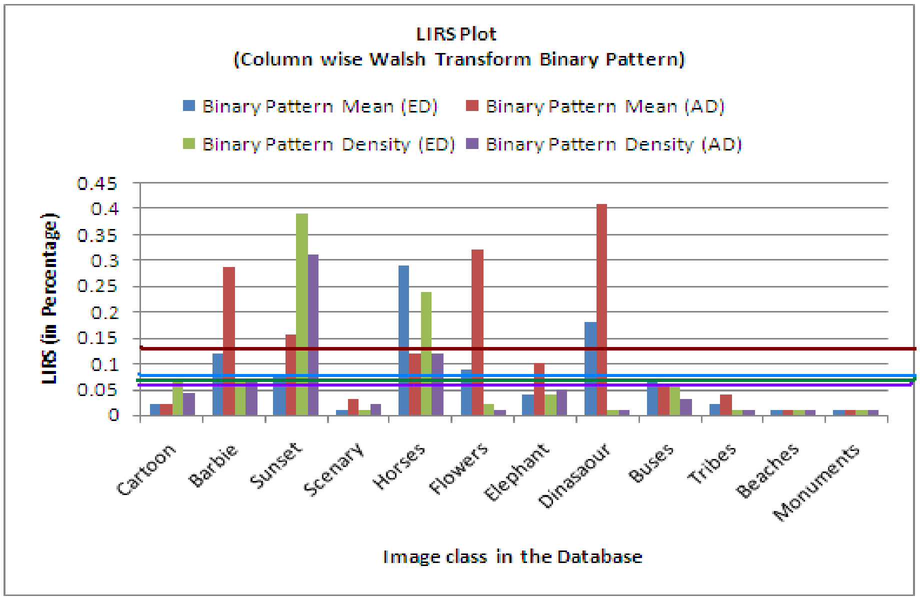

Figure 11: The LIRS Plot of Column wise and Row wise walsh transformed images. Overall Average LIRS performances are 0.078(Mean-ED) ,0.13(Mean-AD) ,0.077(Density-ED) , 0.057(Density-AD)

(Shown with Horizontal staight line).

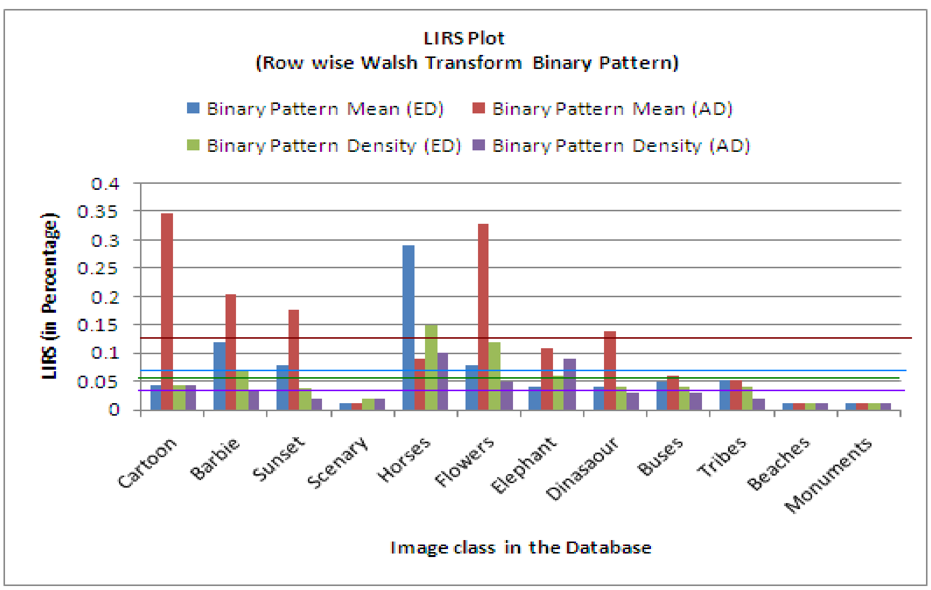

Figure 12: The LIRS Plot of Column wise and Row wise walsh transformed images. Overall Average LIRS performances are 0.068(Mean-ED) ,0.128(Mean-AD) ,0.053(Density-ED) , 0.038(Density-AD) (Shown with Horizontal staight line).

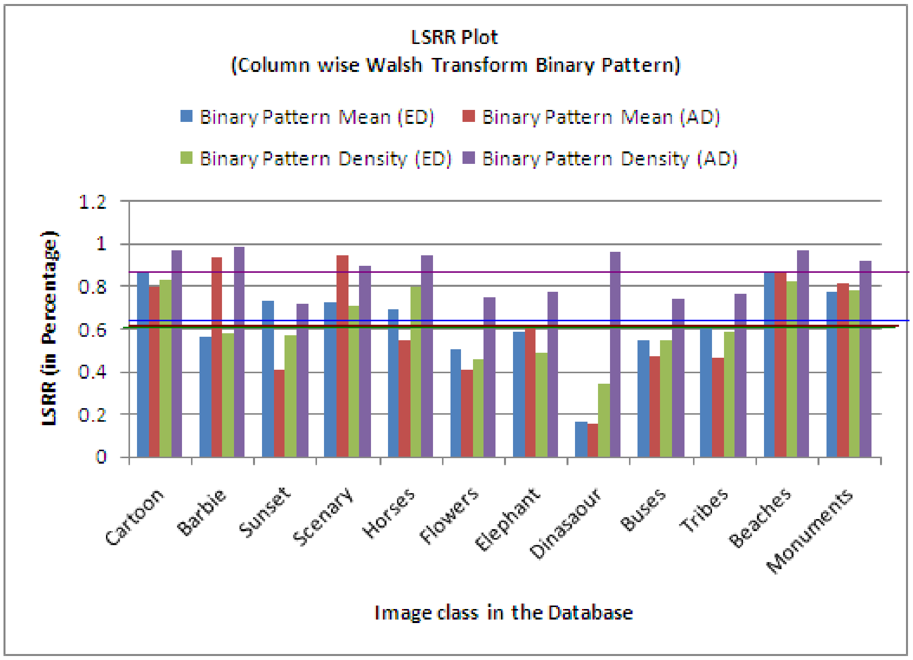

Figure 13: The LSRR Plot of Column wise walsh transformed images. Overall Average LSRR performances are 0.63(Mean-ED) ,0.620(Mean-AD) ,0.627(Density-ED) , 0.867(Density-AD)

(Shown with Horizontal staight lines).

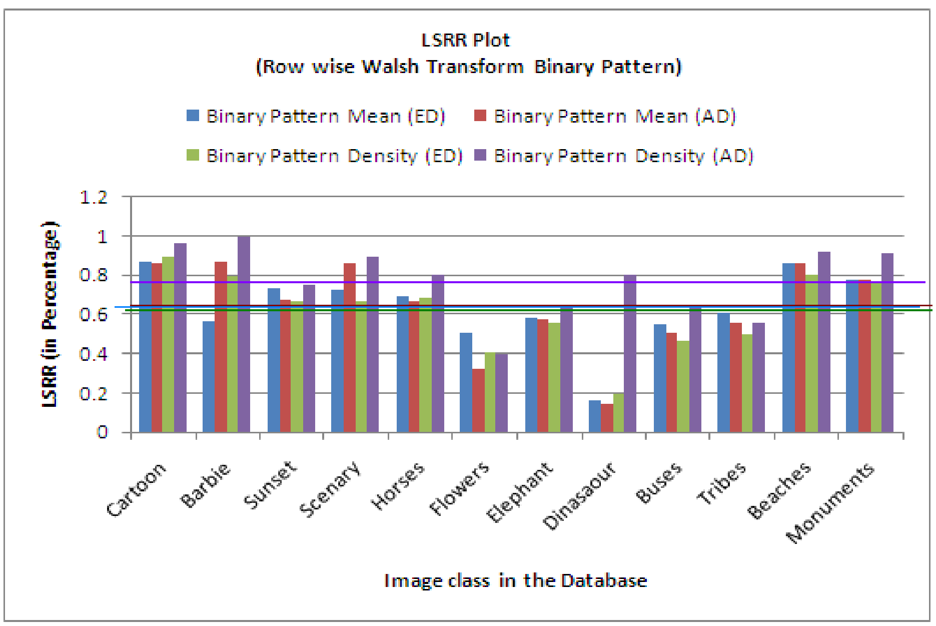

Figure 14: The LSRR Plot of Row wise walsh transformed images. Overall Average LSRR performances are 0.637(Mean-ED) ,0.638(Mean-AD) ,0.616(Density-ED) , 0.774(Density-AD)
(Shown with Horizontal staight lines).

V. CONCLUSION

In this paper we have introduced an innovative idea of using the binary pattern database to extract texture features of the Color images for the purpose of retrieval in CBIR application. We have experimented in both column wise and row wise Walsh transformed images with two approaches of feature extraction namely density distribution of binary pattern in the Pattern database and mean of these binary patterns. The result of work compared with respect to two distance measuring parameters i.e. well known Euclidian distance and efficient and sum of absolute difference which has lesser computational complexity than ED. As far as cross over point of Overall average precision and recall is concerned the column wise Walsh transform with mean of Binary Pattern density with sum of absolute difference as similarity measure gives the best rate of retrieval i.e. more than 50% whereas column wise Walsh transform with Binary Pattern density and Euclidian distance as similarity measure is quite closer to it. We have also measured the performance based on two more parameters i.e. LIRS and LSRR which is shown in the Figure 11-14.These parameters are very useful to measure the retrieval performance of the algorithm . If LIRS is Maximum LSRR is minimum then we can clearly say that the retrieval rate must be very good. Because with LIRS we can measure how maximum relevant images are retrieved as the initial string before retrieval of the first irrelevant image whereas LSRR provides quicker all relevant images are retrieved from the database. For instance see all bar charts (see Figure 9 –Figure 14) to compare the retrieval performance specifically for Diana sour class of image which clearly shows that Diana sour, flowers, sunset etc. class has good performance of precision and recall cross over whereas its has maximum LIRS and minimum LSRR .It is also observed that these parameters vary from method to method and class of images.

REFERENCES

[1] Kato, T., “Database architecture for content based image retrieval in Image Storage and Retrieval Systems” (Jambardino A and Niblack W eds),Proc SPIE 2185, pp 112-123, 1992.

[2] Ritendra Datta,Dhiraj Joshi,Jia Li and James Z. Wang, “ Image retrieval:Idea,influences and trends of the new age”,ACM Computing survey,Vol 40,No.2,Article 5,April 2008.

[3] John Berry and David A. Stoney “The history and development of fingerprinting,” in Advances in Fingerprint Technology, Henry C. Lee and R. E. Gaensslen, Eds., pp. 1-40. CRC Press Florida, 2nd edition, 2001.

[4] Emma Newham, “The biometric report,” SJB Services, 1995.

[5] H. B. Kekre, Dhirendra Mishra, “Digital Image Search & Retrieval using FFT Sectors” published in proceedings of National/Asia pacific conference on Information communication and technology(NCICT 10) 5TH & 6TH March 2010.SVKM’S NMIMS MUMBAI

[6] H.B.Kekre, Dhirendra Mishra, “Content Based Image Retrieval using Weighted Hamming Distance Image hash Value” published in the proceedings of international conference on contours of computing technology pp. 305-309 (Thinkquest2010) 13th & 14th March 2010.

[7] H.B.Kekre, Dhirendra Mishra,“Digital Image Search & Retrieval using FFT Sectors of Color Images” published in International Journal of Computer Science and Engineering (IJCSE) Vol. 02,No.02,2010,pp.368-372 ISSN 0975-3397 available online at http://www.enggjournals.com/ijcse/doc/IJCSE10-02- 02-46.pdf

[8] H.B.Kekre, Dhirendra Mishra, “CBIR using upper six FFT Sectors of Color Images for feature vector generation” published in International Journal of Engineering and Technology(IJET) Vol. 02, No. 02, 2010, 49-54 ISSN 0975-4024 available online at http://www.enggjournals.com/ijet/doc/IJET10-02- 02-06.pdf

[9] H.B.Kekre, Dhirendra Mishra, “Four walsh transform sectors feature vectors for image retrieval from image databases”, published in international journal of computer science and information technologies (IJCSIT) Vol. 1 (2) 2010, 33-37 ISSN 0975-9646 available online at http://www.ijcsit.com/docs/vol1issue2/ijcsit2010010201.pdf

[10] H.B.Kekre, Dhirendra Mishra, “Performance comparison of four, eight and twelve Walsh transform sectors feature vectors for image retrieval from image databases”, published in international journal of Engineering, science and technology(IJEST) Vol.2(5) 2010, 1370-1374 ISSN 0975-5462 available online at http://www.ijest.info/docs/IJEST10-02-05-62.pdf

[11] H.B.Kekre, Dhirendra Mishra, “ density distribution in walsh transfom sectors ass feature vectors for image retrieval”, published in international journal of compute applications (IJCA) Vol.4(6) 2010, 30-36 ISSN 0975-8887 available online at http://www.ijcaonline.org/archives/volume4/number6/829-1072

[12] H.B.Kekre, Dhirendra Mishra, “Performance comparison of density distribution and sector mean in Walsh transform sectors as feature vectors for image retrieval”, published in international journal of Image Processing (IJIP) Vol.4(3) 2010, ISSN 1985-2304 available online at http://www.cscjournals.org/csc/manuscript/Journals/IJIP/Volume4/Issue3/IJIP-193.pdf

[13] H.B.Kekre, Dhirendra Mishra, “Density distribution and sector mean with zero-sal and highest-cal components in Walsh transform sectors as feature vectors for image retrieval”, published in international journal of Computer scienece and information security (IJCSIS) Vol.8(4) 2010, ISSN 1947-5500 available online http://sites.google.com/site/ijcsis/vol-8-no-4-jul-2010

[14] Arun Ross, Anil Jain, James Reisman, “A hybrid fingerprint matcher,” Int’l conference on Pattern Recognition (ICPR), Aug 2002.

[15] A.M. Bazen, G. T. B.Verwaaijen, S. H. Gerez, L. P. J. Veelenturf, and B. J. van der Zwaag, “A correlation-based fingerprint verification system,” Proceedings of the ProRISC2000 Workshop on Circuits, Systems and Signal Processing, Veldhoven, Netherlands, Nov 2000.

[16] H.B.Kekre, Tanuja K. Sarode, Sudeep D. Thepade, “Image Retrieval using Color-Texture Features from DST on VQ Codevectors obtained by Kekre’s Fast Codebook Generation”, ICGST International Journal on Graphics, Vision and Image Processing (GVIP), Available online at http://www.icgst.com/gvip

[17] H.B.Kekre, Sudeep D. Thepade, “Using YUV Color Space to Hoist the Performance of Block Truncation Coding for Image Retrieval”, IEEE International Advanced Computing Conference 2009 (IACC’09), Thapar University, Patiala, INDIA, 6-7 March 2009.

[18] H.B.Kekre, Sudeep D. Thepade, “Image Retrieval using Augmented Block Truncation Coding Techniques”, ACM International Conference on Advances in Computing, Communication and Control (ICAC3-2009), pp.: 384-390, 23-24 Jan 2009, Fr. Conceicao Rodrigous College of Engg., Mumbai. Available online at ACM portal.

[19] H.B.Kekre, Tanuja K. Sarode, Sudeep D. Thepade, “DST Applied to Column mean and Row Mean Vectors of Image for Fingerprint Identification”, International Conference on Computer Networks and Security, ICCNS-2008, 27-28 Sept 2008, Vishwakarma Institute of Technology, Pune.

[20] H.B.Kekre, Vinayak Bharadi, “Walsh Coefficients of the Horizontal & Vertical Pixel Distribution of Signature Template”, In Proc. of Int. Conference ICIP-07, Bangalore University, Bangalore. 10-12 Aug 2007.

[21] J.L.Walsh, “A closed set of orthogonal functions”American Journal of Mathematics, Vol 45,pp.5-24,year 1923.

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