BINS APPROACH TO IMAGE RETRIEVAL USING STATISTICAL PARAMETERS BASED ON HISTOGRAM PARTITIONING OF R, G, B PLANES

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ABSTRACT

In this paper we have proposed a novel technique to retrieve the images from large image databases based on the spatial contents of the image to extract the low level features from it for CBIR. In this work image is separated into 3 planes and for each plane we have calculated the histogram which is partitioned into three equal parts to obtain the 27 bins. These bins are holding the spatial-color information of the image in various forms which is generating the different types of the feature vector databases. Three different set of bins are designed to be used as feature vectors containing the total R,G, and B intensities, in R, G and B bins respectively, second form is containing the mean of R,G and B and third is holding standard deviation of R, G and B values in R, G, B bins respectively. This leads to generation of three feature vector databases where size of each feature vector in all databases is 27. Experimentation includes comparison of 100 query images with 1000 database images (Augmented Wang database) using two similarity measures named Euclidean distance and Absolute distance. Results obtained for three feature databases are compared based on the similarity measures reflecting the performance variations of different approaches used. These results are then analyzed and refined using three criteria in this work named Criterion1: Strong, Criterion2: Average and Criterion3: Weak. It has been observed in our results that bins holding standard deviation of R, G and B intensities performing better among all three approaches and refined results using cireterion3 giving very good results as compared to other two.

KEYWORDS: *CBIR, Histogram Partitioning, Mean, Standard Deviation, Euclidean Distance, Absolute Distance, LIRS, LSRR, PRCP.*

I. INTRODUCTION

This paper explores the new and effective technique to retrieve the images from large image databases using the image contents. Early image retrieval methods locate the desired images by matching keywords that are assigned to each image manually. However because of large number of images it is impractical to assign keywords to every image and even difficult to process them manually. Now a days, content based image retrieval seems to be very popular and fastest growing research area. In all the CBIR system the overall work can broadly be divided into two parts, First, Feature extraction and Second, selecting and applying the similarity measure which will retrieve the image closer to query with less complexity and good accuracy in terms of precision and recall [1],[2]. Most of the CBIR systems are using the primitive features of the images denoting the visual information including the color, shape and texture features [3],[4],[5],[6]. Color is independent of image size and orientation, as it is robust to background complication.[7],[8],[9],[10],[11]. We are focusing on the use of color information of the image obtained by calculating the image histograms to extract the feature vectors [12].

Histogram is most commonly used technique to represent global feature of the image which is invariant to translation and rotation of the image [13],[14],[15],[16]. Histogram for an image is constructed by counting the number of pixels of each color intensity level. [17], [18], [19],[20],[21]. If we consider the histogram as a feature vector directly for comparison process, although it is small vector representing the image it would be better if further we can reduce the size of the feature vector so that comparison computations can be minimized and complexity can be reduced [22],[23]. Keeping this goal in mind we have calculated the histogram of each plane of the image which is divided into three equal parts. This partitioning of the histogram is based on dividing the number of pixels equally in three parts. The intensity where this partition takes place is taken into consideration on the basis of which actual 27 bins are formed to be considered as feature vectors. Here three feature vector databases are formed based on three different parameters. Feature extraction from each of these bins is nothing but the color information representation in three different ways as the total intensities, average intensities and the standard deviation of these intensities in each bin. As second part of CBIR, this system is tested using the query by image, given as input which is compared with the 1000 database image feature vectors using two similarity measures named Euclidean distance and Absolute distance [24],[25]. An image similar to the query where the distance is less is selected for retrieval. To evaluate the performance of the system instead of using the traditional parameters precision and recall as it is, we are using 'Precision- Recall Cross over Point (PRCP)' to evaluate our system's performance [26], [27]. Further these results are analyzed and refined using three simple criteria designed [28], [29]. Criterion 1, and 2 and 3 gives the gradual increase in the performance level of our system. Orientation of this proposed work is as follows: Section2 explains the feature extraction process, Section3 describes application of the similarity measures, experimental results and analysis, and performance evaluation of the system is given in section 4, Work done is concluded section 5.

II. FEATURE EXTRACTION

Feature extraction process starts with separation of image into R, G, B planes. Then computing the histogram of each plane which is divided into parts to generate the bin addresses and finally it ends with formation of bins to represent the feature vectors is explained below.

2.1. Histogram Plotting and Partitioning

As mentioned above each image for which the feature to be extracted is separated into R, G and B planes [32]. Histogram for each plane is computed separately. Once the histograms are obtained each is divided into 3 equal parts based on the total number of pixels in the image . This gives two separation points of three parts, where the intensity levels are taken into consideration as Grey Level 1 and 2 as GL1 and GL2 respectively. Each part of histogram is assigned an id as 0, 1 and 2. As shown in figure.1. Same process is repeated for 3 planes.

a. Original Image b. Red Plane c. Histogram of Red Plane with Partitions

GL1= (m*n)/3

GL2= 2(m*n)/3

Where, **m** no of rows and **n** is no of columns of an image

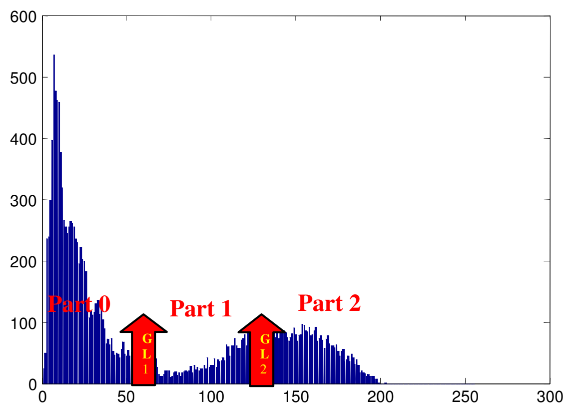

Figure1. a. Original Image b. Red plane c. Histogram with partitions (Red Plane)

2.2. Bins Formation

This process uses the information obtained from the histogram. As shown in Figure 1, the histogram gives two grey levels named as GL1 and GL2 for 3 partitions. These grey levels are used as threshold for the pixel to be counted in a bin which decides that in which part of the histogram it falls either 0, 1 or 2. According to this logic, for each pixel from the original image with its R, G, B values it will be checked that which part it belongs in the respective histogram and a flag will be assigned to it. This way the flag will have 3 values in range (000 to 222) total 27 possibilities as each pixel has three components R, G and B. This 3 digit flag assigned to each pixel actually generates the address of the bin for that pixel to reside or to be counted. The bin address can be identified using the following Equation1.

$$Bin\_Address = (9r + 3g + b) \tag{1}$$

Where ***'r,''g'*** and ***'b'*** are the flag digits for R, G and B values respectively for the pixel in process

e.g if the flag values are r =2, g=1 and b=1 then that pixel will be counted in Bin_22.

2.3. Feature Vector Databases

Once the bins are formed as explained in 2.1 and 2.2, we thought of the roles these bins can play in terms of containing the information. Based on this we commanded the bins to carry pixel information in 3 different ways which classifies the bins into 3 formats. First is 'Bin_Total_R_G_B' holds the total red, green and blue intensities of the pixels counted in that particular bin separately. Second is 'Bin_Mean_R_G_B' carrying the mean R, G, and B values of the number of pixels in each bin and third format is 'Bin_Standard_deviation_R_G_B' which counts the standard deviation of the R, G, B intensities of the number of pixel in each bin separately. The way these parameter are computed is given equation 2, 3 and 4. As explained earlier total bins obtained are 27 from 000 to 222. and as we are considering R,G B separately along with the three parameters to represent the feature vector; we have multiple feature vector databases 3(R, G and B) for each of the three formats- Total, Mean and Standard deviation where each feature vector is having 27 components. Same process is applied to all 1000 images in the database and feature databases are prepared as pre-processing part of this work. Means in all there are 9 feature vector databases for which the comparison should take place.
Let there be N pixels in a bin. Each pixel having intensity level as Ri, Gi and Bi respectively for R,G and B planes.

Bin_Total_R →

$$R_T = \sum_{i=1}^{N} R_i \tag{2}$$

Bin_Mean_R →

$$\overline{R} = \frac{1}{N}\sum_{i=1}^{N} R_i = \frac{R_T}{N} \tag{3}$$

Bin_Standard_deviation →

$$R_{SD} = \frac{1}{N}\sqrt{\sum_{i=1}^{N}\left(R - \overline{R}\right)^2} \quad \text{Where } \overline{R} \text{ is Bin\_Mean\_R} \tag{4}$$

Similarly the parameter values Gi and Bi for Green and Blue planes are calculated respectively**.**

III. FEATURE VECTOR MATCHING AND INDEXING

Once the feature vector databases are prepared, comparison process has to be followed. In this work feature vector is extracted for the query image just the same way it was extracted for all database images. Two similarity measures, Euclidean distance and absolute distance [24], [25] are used in actual comparison process. When user enters the query image; feature vector will be extracted and then Euclidean and Absolute distance between these two is calculated using following equations 2 and 3 respectively. Now to find the match with query; we have selected the images from the database having less distances in the retrieval set. In this process no thresholding is done but to limit this retrieval, we have taken first 100 images having less distances are selected for the final retrieval (Out of 1000). This may include either relevant or irrelevant images.

Euclidean Distance :

$$D_{QI} = \sqrt{\sum_{i=1}^{n} \left|(FQ_i - FI_i)\right|^2} \quad (5)$$

Absolute Distance:

$$D_{QI} = \sum_{1}^{n} \left|(FQ_I - FI_I)\right| \quad (6)$$

IV. Experimental Results and Analysis

4.1 Database and Query Image

All the approaches discussed above are experimented with the database of 1000 bmp images (Augmented Wang Database). It includes 10 different categories of images wherein each of them has got 100 images of their own (Includes Flower, Sunset, Mountain, Building, Bus, Dinosaurs, Elephant, Barbie, Mickey and Horse). Sample images from the database are shown in Figure 2.
In this system query is provided as an example image. For which the feature extraction process will be applied and query image feature vector will be obtained. This will be compared with all database feature vectors using two similarity measure given in Equation 5 and 6. For our experiments we have taken 100 images selected randomly from the database itself to be given as query to this system to tests its performance.

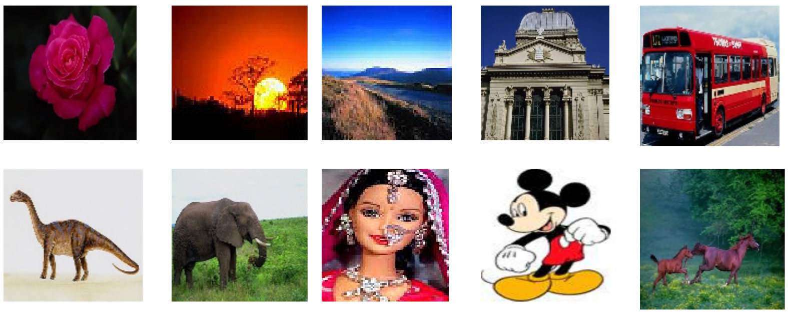

Figure 2. Sample Database Images from 10 Different Classes

4.2 Performance Evaluation

In most of the CBIR system, two parameters are widely used for the performance evaluation that are precision and recall [30],[31]. In our work as we have not chosen the threshold on trial and error which sometimes very tedious for the distance calculated between query and database images. Instead we are taken the initial string of 100 images to be retrieved as the output for the given query. Before we do this it is required that distances should be in sorted order so that first 100 images closer to query will be obtained. As we are taking first 100 for retrieval and we have total 100 images for each class in database this generates the plot of 'Precision and Recall Cross Over Point'. We are using two more new parameters given in Equations 7 and 8 respectively as 'LIRS- **L**ength of **I**nitial **R**elevant **S**tring' and 'LSRR- **L**ength of the **S**tring to **R**etrieve all **R**elevant images' for the comparison and analysis of the results to evaluate the system performance [33].

$$LIRS = \frac{Length\_of\_Initial\_Relevant\_String}{Total\_images\_of\_that\_class\_in\_database} \tag{7}$$

$$LSRR = \frac{Length\_of\_String\_to\_Retrive\_all\_Relevant\_images}{Total\_images\_in\_database} \tag{8}$$

4.3 Results Discussion and Analysis

As discussed above in section 2.3 we have total 9 feature vector databases as 3 for each plane based on three different formats of bins. Results obtained for 100 queries are shown in following tables for each plane and each bin parameter ('Bin_Total_R_G_B','Bin_Mean_R_G_B' and 'Bin_Standard_deviation_R_G_B'). Table 1, 2 and 3 shows the results of 100 query images for Red, Green and Blue plane for all types of bins using two similarity measures Euclidean Distance (ED) and Absolute Distance (AD). The values obtained in last row of all the tables are the average of 10 queries executed from each of the 10 classes; last row is the total of all relevant images retrieved out of 10,000.

In these results we can observe that performance of the bins goes on increasing from parameter Bin_Total_R_G_B' to Bin_Standard_deviation_R_G_B'. For Bin_Total_R_G_B' relevant retrieval is around 4000 and 4100 for ED and AD respectively. For Bin_Mean_R_G_B' it is around 4100 and 4300 for ED and AD respectively and it is very good about 4400 and 4800 for ED and AD respectively for 'Bin_Standard_deviation_R_G_B'.

Table1. Retrieval Result of Red_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

R-Plane						
Total_Ret	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	329	384	326	397	270	326
Sunset	418	378	402	411	338	292
Mountain	269	323	317	348	388	415
Building	247	291	355	359	401	427
Bus	440	460	485	506	402	441
Dinosaur	430	414	462	619	798	873
Elephant	391	385	365	401	478	478
Barbie	251	258	297	304	359	334
Mickey	497	505	580	609	542	589
Horses	635	629	576	487	518	581
TOTAL	3907	4027	4165	4441	4494	4756

Table2. Retrieval Result of Green_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

G-Plane						
Total_Ret	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	546	624	609	616	414	451
Sunset	462	492	304	274	416	386
Mountain	257	289	230	280	283	330
Building	235	288	333	335	399	443
Bus	408	421	358	416	380	406
Dinosaur	425	397	486	674	809	866
Elephant	385	397	312	349	412	389
Barbie	247	251	254	285	251	283
Mickey	501	500	534	610	500	534
Horses	497	532	391	399	439	491
TOTAL	3963	4191	3811	4238	4303	4579

If these retrieval results compared in terms of precision and recall cross over point, it has achieved quite good results, 0.4 for Bins_ total and Mean, and 0.5 for Bins standard deviation for the absolute distance. We can see that absolute distance is performing well for all the approaches and proving its best as similarity measure. Performance of these results are evaluated using two parameters explained in equation 7 and 8 and expressed in Tables 4, 5, 6 and 7, 8, 9 for LIRS and LSRR respectively for R, G and B planes

Table3. Retrieval Result of Blue plane, for 100 queries using ED and AD for Bin_Total, Mean and Standard deviation R_G_B'

B-Plane						
Total_Ret	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	330	406	490	513	524	577
Sunset	566	575	458	457	334	441
Mountain	338	328	283	348	259	283
Building	224	273	243	289	284	348
Bus	409	400	471	531	393	424
Dinosaur	406	368	553	642	669	670
Elephant	300	309	256	274	250	262
Barbie	253	251	267	299	312	327
Mickey	506	493	464	571	367	428
Horses	576	596	536	473	494	566
TOTAL	3908	3999	4021	4397	3886	4326

Table4. LIRS Result of Red_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

R-Plane						
LIRS	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	13	13	5	6	5	8
Sunset	8	7	6	5	5	5
Mountain	2	3	2	3	2	2
Building	2	3	2	2	3	4
Bus	11	16	9	10	4	4
Dinosaur	11	11	10	22	26	45
Elephant	5	5	3	3	8	7
Barbie	5	5	7	6	12	14
Mickey	14	16	10	11	20	23
Horses	13	17	16	13	18	24
Percentage %	9	10	7	8	10	14

Table5. LIRS Result of Green_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

G-Plane						
LIRS	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	8	13	5	6	9	9
Sunset	6	5	4	3	10	8
Mountain	3	3	2	2	3	3
Building	2	2	2	2	3	3
Bus	10	13	9	6	5	6
Dinosaur	11	12	9	20	29	39
Elephant	4	5	2	3	5	4
Barbie	3	4	4	5	6	9
Mickey	11	13	9	13	11	14
Horses	10	14	9	8	15	14
Percentage %	7	8	6	7	10	11

Table6. LIRS Result of Blue_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

B-Plane						
LIRS	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	6	6	9	10	17	19
Sunset	9	9	7	9	7	11
Mountain	4	3	2	2	3	3
Building	3	3	3	3	3	3
Bus	12	17	19	15	9	11
Dinosaur	10	11	13	20	16	18
Elephant	3	4	2	4	4	4
Barbie	5	5	6	6	6	8
Mickey	10	8	10	12	14	13
Horses	7	12	8	9	18	20
Percentage %	7	8	8	9	10	11

All the entries shown in table 4, 5 and 6 are actually the average of 10 queries from each class using similarity measures ED and AD. Last row entries in all three tables is average percentage. We can observe in above tables 4, 5 and 6 that the length of initial string of relevant images is good for 'Bin_Standard_deviation_R_G_B' compared to the other two types of bins with absolute distance as a similarity measure.

Table7. LSRR Result of Red_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

R-Plane						
LSRR	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	71	68	66	66	99	99
Sunset	81	83	82	81	99	99
Mountain	68	69	70	70	64	62
Building	78	74	58	60	79	67
Bus	64	56	63	55	83	79
Dinosaur	98	99	75	53	16	14
Elephant	86	89	63	64	63	52
Barbie	99	100	99	98	98	99
Mickey	100	100	96	97	96	81
Horses	56	61	70	74	54	45
Percentage %	80	80	74	72	75	70

Table8. LSRR Result of Green_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

G-Plane						
LSRR	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	52	33	46	56	77	79
Sunset	66	71	79	79	97	99
Mountain	73	77	85	85	82	79
Building	80	79	69	69	75	55
Bus	69	66	63	60	77	79
Dinosaur	98	100	68	48	21	15
Elephant	87	91	68	67	65	68
Barbie	99	100	99	99	99	99
Mickey	100	100	100	99	97	94
Horses	63	70	75	75	88	85
Percentage %	79	78	75	74	78	75

Table9. LSRR Result of Blue_plane, 100 queries using ED and AD for Bin_Total, Mean and Standard_deviation_R_G_B'

B-Plane						
LSRR	**RGB_BINS**		**MEAN_BINS**		**STD_BINS**	
QUERY	ED	AD	ED	AD	ED	AD
Flower	55	53	61	70	61	70
Sunset	39	49	58	61	91	89
Mountain	75	81	92	91	93	95
Building	80	80	76	78	82	85
Bus	71	70	65	65	78	84
Dinosaur	98	100	63	47	33	35
Elephant	87	90	68	70	92	91
Barbie	99	100	99	99	97	100
Mickey	100	100	99	98	99	99
Horses	52	49	66	72	62	65
Percentage %	76	77	75	75	79	81

Table 7, 8 and 9 showing the results of the second evaluation parameter LSRR, which identifies the length of the string of images required to retrieved all the images of query class from the database, When we observed these results of the second parameter LSRR, it can be noticed that to retrieve all relevant which means to make the recall value 1 the length of string of images required to retrieve is almost 70 to 80 %. Overall, when we compared the approaches standard deviation is performing better among three parameters. It requires length around 70 to 75 % to retrieve all relevant images from the database

The results obtained for 3 planes are analyzed and we tried to refine them further using the three criterion [26] , Criterion1, 2 and 3. Using these criteria we could combine the three sets of results obtained for 3 planes separately. Based on the way they are combined they have produce different results.

Criterion1 is called Strong_R_G_B : According to this criterion the image will be retrieved in final set only and only if it being retrieve in all the three planes.

Criterion2: is Called Average _R_G_B: According to this criterion the image will be retrieved in final set if it being retrieve in any of the two planes out of three

Criterion 3 is called Weak R_G_B **:** According to this the image can be retrieved in final set even if it being retrieve in any one plane out of the three results.

R,G and B Results combined using these three criteria for all bin parameters and for both the similarity measures are plotted in following charts 1 , 2 and 3 for 'Bin_Total__R_G_B', 'Bin_Mean_R_G_B' and 'Bin_Standard_deviation_R_G_B' respectively using both similarity measures ED and AD. The values plotted are the precision recall cross over points obtained for the final refined results. These values are plotted as average percentage retrieval of similarity in terms of cross over points.

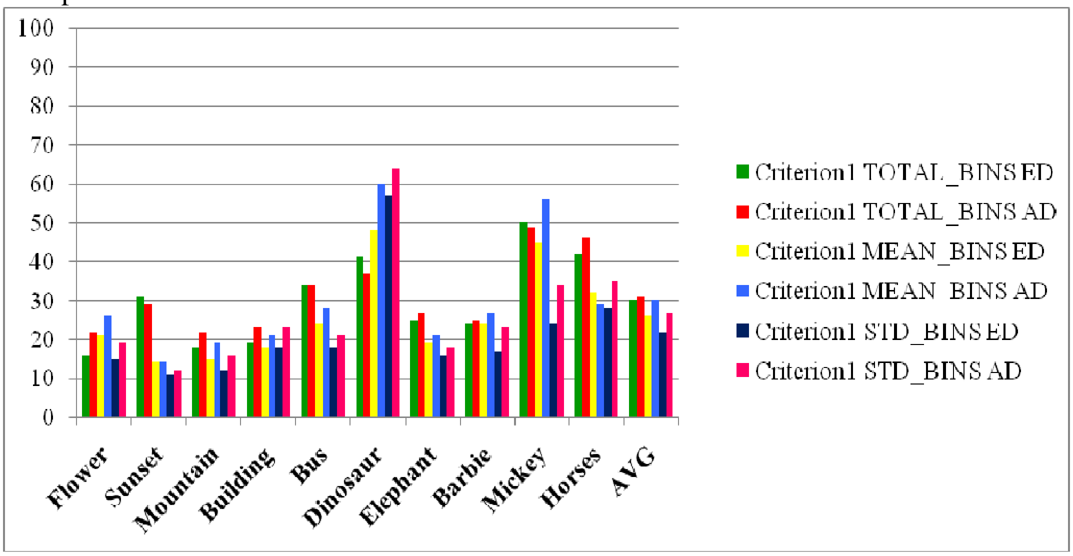

Figure 3: Criterion1 Applied for Total_Bins, Mean_Bins and STD_Bins

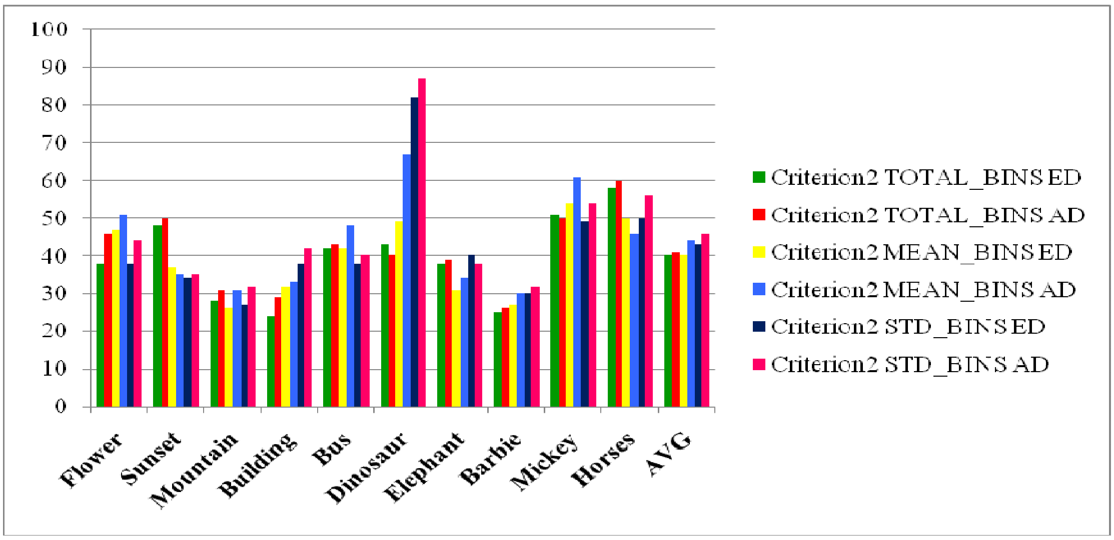

Figure 4: Criterion2 Applied for Total_Bins, Mean_Bins and STD_Bins

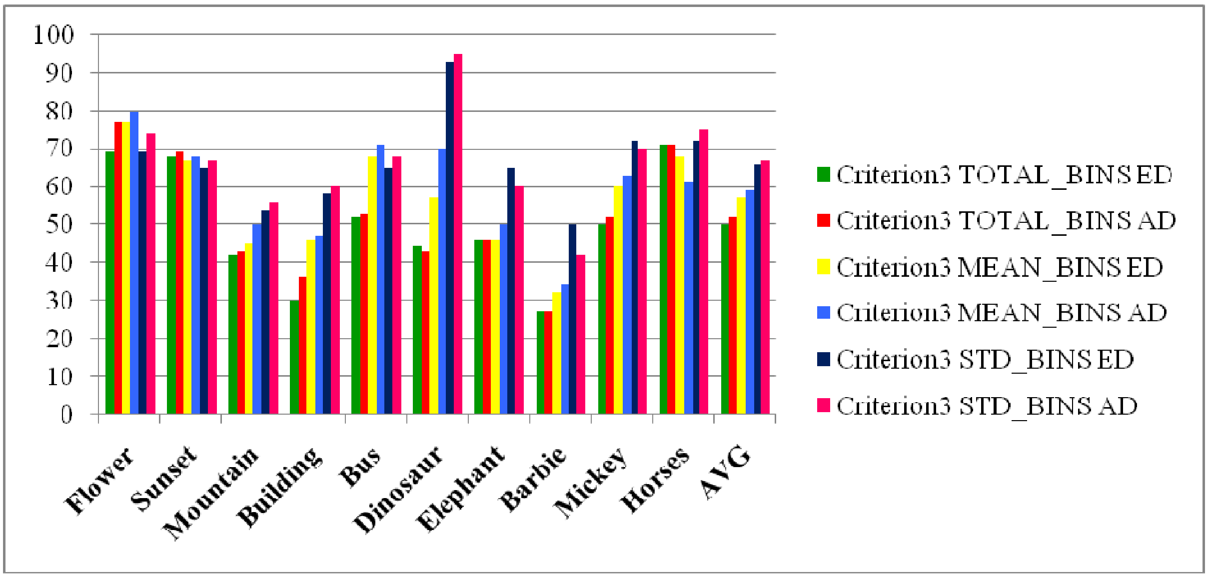

Figure 5: Criterion3 Applied for Total_Bins, Mean_Bins and STD_Bins

V. CONCLUSION

In this work information obtained from unequalized histograms is utilized efficiently and effectively to form the bins which has produced very good results just on the basis of color information of the image. Separating the image into 3 planes and obtaining their histograms separately produces the discriminate color information from one image which is used to represent the feature vector.

Different parameters used to represent the pixel's color information produced different bins formats named Bin_Total_R_G_B bins, Bin_Mean_R_G_B bins and Bin_Standard Deviation_R_G_B bins. Among these three types of feature vector of 27 components, parameter standard deviation is giving very good results as compared to the other two.

Similarity measure selection is highlighting the effective use of Absolute distance for this system. It reduces the computational as well as time complexity and has produced quite good results as compared to the Euclidean distance.

Positive change in the retrieval results is obtained after combining and refining them using three criteria. Observing the figure 3, 4 and 5 it can be delineated that among these results criterion3 is proving its best by giving the best PRCP (Precision Recall Cross over Point) values, which is reached to 9 for few query images and also noticed that it is above 7 for 60% of the query images.

REFERENCES

[1] J.R.Smith and S.-F Chang, "Integrated spatial and feature image query", Multimedia Syst. 7(2), 129-140(1999).

[2] R. Schettini, G. Ciocca, S Zuffi. "A survey of methods for colour image indexing and retrieval in image databases", Color Imaging Science: Exploiting Digital Media, (R. Luo, L. MacDonald eds.), J. Wiley, 2001.

[3] J. Smith and S. Chang. "Automated image retrieval using color and texture". Technical Report CU/CTR 408-95-14, Columbia University, July 1995.

[4] John R. Smith and Shih-Fu Chang,"Tools and Techniques for Color Image Retrieval" Columbia University Department of Electrical Engineering and Center for Telecommunications Research New York, N.Y. 10027.

[5] Y. Liu, D. Zhang, G.Lu, W.Y. Ma,, 2007. "A survey of content-based image retrieval with high-level semantics", The journal of the recognition society,pp.262- 282 DOI:10.1016/j.patcog.2006.04.045

[6] P. B. Thawari & N. J. Janwe, "CBIR Based On Color And Texture" International Journal of Information Technology and Knowledge Management January-June 2011, Volume 4, No. 1, pp. 129-132.

[7] M. J. Swain and D. H. Ballard. "Color indexing", International Journal of Computer Vision, 7:1 1991.

[8] N.K.Kamila, ,Pradeep Kumar Mallick, Sasmita Parida B.Das," Image Retrieval using Equalized Histogram Image Bins Moments", Special Issue of IJCCT Vol. 2 Issue 2, 3, 4; 2010 for International Conference [ICCT-2010], 3rd-5th December 2010
[9] H.B.Kekre, Sudeep D. Thepade, "Image Blending in Vista Creation using Kekre's LUV Color Space", SPIT-IEEE Colloquium and International Conference, Sardar Patel Institute of Technology, Andheri,Mumbai, 04-05 Feb 2008.
[10] James Hafner, Harpreet S.Sawhney, Will Equits, Myron Flickner and Wayne Niblack, "Efficient Color Histogram Indexing for Quadratic Form Distance Functions", IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 17, No. 7, July 1995.
[11] M. Rautiainen and D. Doermann, "Temporal Color Correlograms for Video Retrieval",Pattern Recognition, Proceedings of 16th International Conference, vol. 1, Aug. 2002, pp. 267-270
[12] Ryszard S. Chora´s"Image Feature Extraction Techniques and Their Applications for CBIR andBiometrics Systems" international journal of biology and biomedical engineering,2007.
[13] P.S.Suhasini , 2dr. K.Sri Rama Krishna, Dr. I. V. Murali Krishna, "Cbir Using Color Histogram Processing", Journal of Theoretical and Applied Information Technology, 2005 - 2009 JATIT.
[14] J. Domke, Y. Aloimonos, "Deformation and viewpoint invariant color histograms", Proc.BMVC (British Machine Vision Conference), September 2006, Edinburgh, UK.
[15] J. Huang, S. Kumar, M. Mitra, W. Zhu, and R, Zabih, "Image indexing using color correlograms" InProc. of the IEEE Computer Society Conference on Vision and Pattern Recognition, pages 762–768,1997.
[16] K. Konstantinidis , A. Gasteratos , I. Andreadis, "Image retrieval based on fuzzy color histogram processing", Optics Communications 248 (2005) , 375–386.
[17] S. Flank, P. Martin, A. Balogh, and J. Rothey. PhotoFile: "A digital library for image retrieval". InProc. of International Conference on Multimedia Computing and Systems, Washington, DC, May1995. IEEE Computer Society
[18] V. Vijaya Kumar1, N. Gnaneswara Rao2, A.L.Narsimha Rao3, and V.Venkata Krishna4"IHBM: Integrated Histogram Bin Matching For Similarity Measures of Color Image Retrieval", International Journal of Signal Processing, Image Processing and Pattern Recognition, Vol 2, No.3, September 2009.
[19] Shengjiu Wang, "A Robust CBIR Approach Using Local Color Histograms" report submitted to University of aberta
[20] Sangoh Jeong , "Histogram-Based Color Image Retrieval", Psych221/EE362 Project Report, Mar.15, 2001.
[21] A Vadivel, A K Majumdar, Shamik Sural, " Perceptually Smooth Histogram Generation from the HSV Color Space for Content Based Image Retrieval".
[22] Ole Andreas, Flaaton Jonsgard, "Improvements on color histogram based CBIR,2005"
[23] Neetu Sharma, Paresh Rawat, and jaikaran Singh, "Efficient CBIR Using Color Histogram Processing", Signal & Image Processing : An International Journal(SIPIJ) Vol.2, No.1, March 2011.
[24] H.B.Kekre, Dhirendra Mishra, "Sectorization of DCT-DST Plane for Column wise Transformed Color Images in CBIR" ICTSM-11, at MPSTME 25-27 February, 2011 on Springer Link.
[25] H. B. Kekre , Kavita Sonawane, "Feature Extraction in Bins Using Global and Local thresholding of Images for CBIR" International Journal Of Computer Applications In Applications In Engineering, Technology And Sciences, ISSN: 0974-3596, October '09 – March '10, Volume 2 : Issue 2 .
[26] H. B. Kekre , Kavita Sonawane, "Query Based Image Retrieval Using kekre's, DCT and Hybrid wavelet Transform Over 1st and 2nd Moment" International Journal of Computer Applications (0975 – 8887), Volume *– No.*, October 2011.
[27] H.B.Kekre, Dhirendra Mishra "Sectorization of Full Kekre's Wavelet Transform for Feature extraction of Color Images",(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No.2, February 2011.
[28] H. B. Kekre, Kavita Sonawane, 'Retrieval of Images Using DCT and DCT Wavelet Over Image Blocks" (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 10, 2011.
[29] H. B. Kekre, Kavita Sonawane "Standard Deviation of Mean and Variance of Rows and Columns of Images for CBIR" WASET International Journal of Computer, Information and System Science and Engineering (IJCISSE), Volume 3, Number 1, pp.8-11, 2009.
[30] Dr. H. B. Kekre Kavita Sonavane "CBIR Using Kekre's Transform over Row column Mean and Variance Vector " (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 05,2010, 1609-1614.
[31] Dr. H. B. Kekre, Dhirendra Mishra "Image Retrieval using DST and DST Wavelet Sectorization", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 6, 2011.

[32] Dr. H. B. Kekre, V.A. Bharadi, S.D. Thepade , B.K. Mishra, S.E. Ghosalkar , S.M. Sawan “Content Based Image Retreival Using Fusion of Gabor Magnitude and Modified Block Truncation Coding” International Conference on Emerging Trends in Engineering & Technology (ICETET_10) 19-21 November 2010, held at BITS Goa, by G.H. Raisoni College of Engineering, Nagpur, India. IEEE Xplore.

[33] H B Kekre, D. Mishra “Full DST Sectorization for Feature Vector Generation in Content Based Image Retrieval” pp.307-314, ICWET-2011, February 26-27, 2011 Uploaded on ACM Portal.

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