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Comparative Performance of Linear and CG Based Partitioning Of Histogram for Bins Formation in CBIR

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Abstract:- This paper presents the CBIR based on bins approach. It introduces a new idea of partitioning the histogram into three parts using Centre of gravity. This partitioning leads to generation of 27 bins. In this work we have tried to reduce the feature vector dimension to just 27 bins out of 256 histogram bins. This paper elaborates the bins approach using linear (LP) and centre of gravity (CG) based histogram partitioning for generation of 27 bins. Image contents extracted to these bins are the count of pixels falling in the specific range of intensities plotted in the R, G and B histograms. These contents are process further by computing the statistical first four moments Mean, Standard deviation, skewness and kurtosis. The moments are computed separately for R, G and B intensities and treated as separate feature vectors and stored in separate feature databases. Experimentation work is carried out using database of 2000 BMP images having 20 classes including few from Wang database. Core part of this CBIR i.e comparison of query and database images is facilitated using three similarity measures namely Euclidean distance(ED), Absolute distance (AD) and Cosine correlation distance (CD). Performance of the proposed CBIR system is evaluated using three parameters Precision Recall Cross over Point (PRCP), Longest String (LS), Length of String to Retrieve all Relevant (LSRR).

Keywords:- CBIR, Bins, Centre of Gravity, Linear Partitioning**,** Mean, Standard deviation, Skewness, Kurtosis, Euclidean distance, Absolute distance, cosine correlation distance, Precision recall Cross over Point, Longest String, Length of String to Retrieve all Relevant.

I. INTRODUCTION

CBIR system presented in this paper is based on the novel idea of partitioning the histogram into three parts. Two partitioning techniques have been used; linear partitioning and using centre of gravity (CG) partitioning. Linear partition can be easily used for dividing histogram into three equal parts. But new portioning is introduced with the help of CG to get three partitions of histogram. There are two image retrieval techniques, text based retrieval and content based retrieval. Text based image retrieval has many drawback and constraints. It requires image annotations which is again subjective to human perception [1] [2]. Feature extraction and query comparison with database image are the significant stages for any CBIR system. Invention of new feature extraction methods is challenging and vast area of research for CBIR researchers. CBIR features broadly classified into local and global image features [3][4]. There are two ways to extract image features, local and global approach. Global approaches extract features of the object that are generally properties of the object as a whole, such as colour histograms or texture and shape. In local approaches, image will be divided into smaller regions; information of these local regions will be processed to extract the image features. Generally local features are computed at multiple points in the image and are consequently more robust to any variations [5][6][7]. Easily noticeable image contents can be used effectively as feature vectors to represent the image. It includes mainly three contents, color, texture and shape of the image. Based on these three image contents many CBIR systems have been designed and implemented [8][9]. It is an open area for researchers to represent the image by processing these contents so that huge image contents can be represented using a single feature vector. Content-based image retrieval system can be designed by considering the spatial information of colors by using mul-tiple histograms. [10][11] In colour-based image retrieval, primarily two methods are defined: one based on colour layout [18] and the other based on colour histogram [12]. In the second method, each image is represented by its colour histogram. A histogram is a vector, whose components represent a count of the number of pixels having similar colours in the image. Thus, a colour histogram may be considered to be a signature extracted from a complete image [13] [14]. In literature, Colour histograms extracted from different images are indexed and stored in a database. During retrieval, the histogram of a query image is compared with the histogram of each database image using a standard distance metric like Euclidean distance or Manhattan distance [15][16][17][18][19][20] Feature extraction process illustrated in this paper is based on histogram of R, G and B planes of a BMP image. Colour histograms are invariant to translation, rotation and scaling. Instead of using the 256 bins of histogram for comparing two images here implemented a new idea of partitioning the histogram which leads to reduction of feature vector dimension from 256 bins to 27 bins. This generates the compact feature vector which speeds up the comparison process. Feature extraction begins by separating the image into R, G and B planes. For each plane obtain the histogram which is partitioned into three parts using CG and LP partitioning techniques [21][22][23][24]. This process leads to generation of 27 bins. Information extracted to these 27 bins is the count of pixels falling in the specific intensity range. This information is further processed and four types of feature vectors are computed from it based on the first four absolute moments. Each type of feature with respect to each moment is stored separately. The same feature extraction process is followed for both partitioning techniques and multiple feature vector databases are prepared. Query by example approach is used here to test the system's response. Once query enters into the system a feature vector will be extracted for the same and will be compared with all feature vectors of the images in the database. This comparison is carried out using three similarity measures. One is very commonly used in CBIR systems as distance measure i.e Euclidean distance. Along with this we have tried two more measures namely absolute and Cosine correlation distance. We found them performing better in many cases as compared to Euclidean distance. Output of the CBIR systems is the set of images similar to given query. According to user's point of view, system should retrieve as many as possible images of query class from large size databases. To check and evaluate the system's performance to achieve user's satisfaction, we have used three different parameters namely Precision Recall Cross over Point (PRCP), Longest String (LS) and Length of String to Retrieve all Relevant (LSRR)[24][25][26]. Proposed Work done is organized as follows. Section II describes the Feature extraction process; Section III describes the comparison process carried using distance measures. Section IV illustrates the performance evaluation parameters. Results and discussions are presented in section V. Finally conclusive remarks are given in section VI followed by references.

II. FEATURE EXTRACTION

Feature extraction and comparison process are core phases for any CBIR system. Feature extraction in our work is based on the bins approach. Mainly discussing the bins formation process which actually leads to the feature vector extraction. This process starts from separating the image into R, G and B planes and obtaining their histograms. Following section explains the histogram and it's partitioning using CG and LP.

A. R, G and B Planes with Histograms

Very First step being followed in feature extraction is split the image into R, G and B planes shown as follows in Fig.1 for Barbie image.

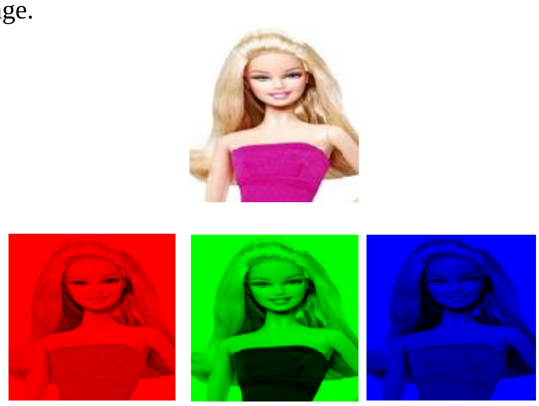


Fig.1: Barbie Image with R, G and B Planes

Then we obtained the histograms for each one of them as shown in Fig.2

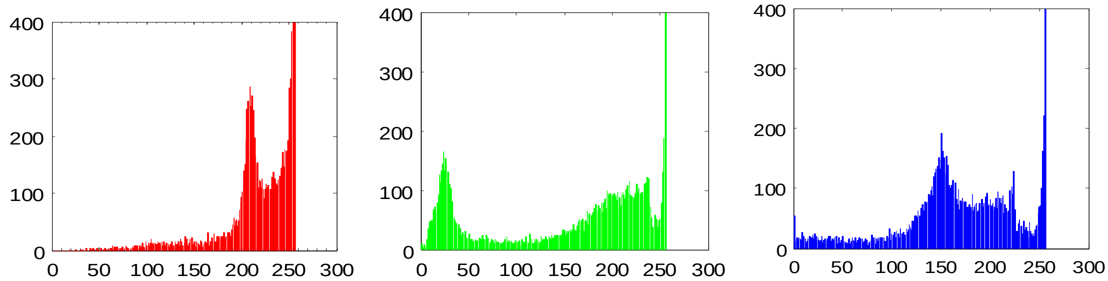


Fig.2: Barbie Image with R, G and B Histograms

B. Histogram Partitioning techniques :CG and LP

This work is focusing on the feature vector dimension reduction along with the improvement in the retrieval results. To reduce the time and computational complexity instead of using all 256 bins of histogram as it is, trying to make it compact by reducing the number of bins. Thus forming only 27 bins from three histograms (R, G and B). Bins are not selected randomly from the histogram for feature vector; rather partitioning used to partition the histograms into three parts so that it will lead to generation of 27 bins. Two techniques used for partitioning are LP and CG.

LP partitioning:

It simply divides the histogram into three parts such that each partition will have same number of pixels. Thus for three parts get two grey levels, acting as threshold for the pixels to be counted in specific partition. It calculates the grey level thresholds for image size **m x n** using eq1.

$$GL1= (m*n)/3 \quad \text{and} \quad GL2= 2(m*n)/3 \tag{1}$$

Here GL1 and GL2 are the two thresholds obtained for three parts. Grey levels for all three (R, G and B) histograms are calculated using eq1. Here obtained the three sets of threshold as follows for sample Barbie image and its histograms shown in Fig.1 and 2 respectively.

LP partitioning → for Fig2. Histograms

RGL1 = 215	RGL2 = 252
GGL1 = 171	GGL2 = 236
BGL1 = 155	BGL2 = 223

Fig3. Shows Green Histogram partitioning using LP at two Grey levels **GGL1 = 171** and **GGL2= 236**.

Similarly we have partitioned the red and Blue histograms with RGL and BGL 1 and 2 respectively.

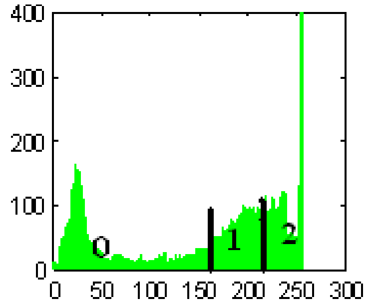


Fig.3: Green Histogram with 0,1 and 2 Parts : LP partitioning

CG Partitioning:

We have first worked with LP where the histogram is divided by just taking the count of pixels into consideration. But one important factor we have missed here is the intensities of the pixels are totally ignored and only count has been taken into account. To solve this issue and without ignoring the pixel intensities this new partitioning is implemented i.e partitioning based on Centre of gravity. As we know CG is the point where surrounding weight is equal. Getting two equal parts using CG is simple by computing CG using eq.2; but getting three uniform partitions cannot be done using the CG formula directly. To facilitate this partitioning here the new logic has been derived to get three partitions having equal moments based on CG and its properties.

$$CG = \left[\frac{(L_1 W_1 + L_2 W_2 + \ldots + L_n W_n)}{\sum_{i=1}^{n} W_i} \right] \tag{2}$$

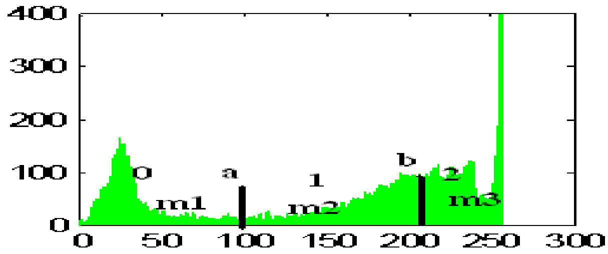


Fig.4: Green Histogram with 0, 1 and 2 Parts : CG partitioning

As shown in Fig.4. we have selected two points a and b so that we will get three units from 0 to a, a to b and b to end point of histogram (256 bins). We are calculating the moments m1, m2 and m3 respectively for these three units around the origin. What we are taking care of is; we are trying to maintain the ratio for moments **m1: m2: m3 as 1: 3: 5** so that the pixels will be distributed uniformly into three parts according to weight or intensities they have. These points a and b are then treated as the threshold grey levels for segregating the pixels into three parts equally. This way, similar to histogram shown in Fig.4 we have calculated a and b using this CG partitioning technique and obtained the following grey levels for R, G and B histogram as follows :

CG partitioning → for Fig2. Histograms

RGL1 = 203	RGL2 = 240
GGL1 = 165	**GGL2 = 228**
BGL1 = 142	BGL2 = 206

The three partitions obtained using LP and CG techniques are identified as part 0, 1 and 2. Now how it leads bins formation is explained as follows:

C. Bins formation and Count of Pixels

After partitioning, start extracting the features for the image under feature extraction process.

Let us, pick up the pixel from the image under process and check its R, G and B intensities.

The partition of the respective histogram it falls assign three flag (either 0,1 or 2) bits for R, G and B (intensity) to that pixel. This three bit flag decides the destination bin for the pixel to be counted. The bin address is actually generated using following equation. It ranges from 000 to 222 i.e. Total 27 bins.

$$Bin\_Address = (9r + 3g + b) \quad (3)$$

Hence if R, G and B intensities of the pixels are falling in partition 0, 2, 2 respectively then flag for the pixel will be set to '022'. This generates the bin address 8; means that pixel is falling in bin no 8.

This was about how the bins formation process takes place. Using LP and CG dividing the histogram into three parts generates 27 bins from 000 to 222. Initially these bins are holding the count of pixels based on the specific intensity range they belong to. Sample 27 bins obtained for the barbie image (Fig.1) is shown in following Fig.5. On top of each bin the value shown represents the count of pixels it contains. Few bins showing zero contents, e.g. bin no.8 contains zero, it means there are no such pixels present in the images having flag '022'.

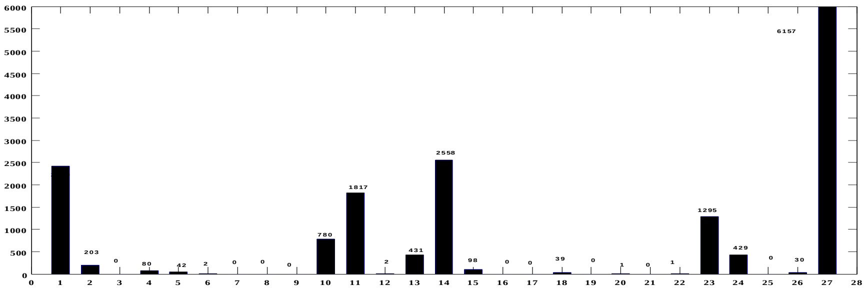


Fig.5: Sample of 27 Bins Showing Count of Pixels for Barbie Image

Now instead of considering only the count of pixels as feature vector, a thought of giving significance to the intensity each pixel has, is implemented so that we can have feature vector with strong discrimination ability. To implement this idea, first four absolute moments for the R, G and B intensities of the pixels counted into each bin are computed. Each moment computed is stored separately in respective feature vector database. This way, it forms four types of feature vector databases based on the type of moment. One more variation based on the color content is used i.e four moments are calculated and stored separately for R, G and B colours. In all total 24 feature vector databases are prepared as, 4 moments x 3 colors x 2 partitioning techniques. This was the pre-processing part of the proposed CBIR system

III. COMPARISON PROCESS: SIMILARITY MEASURES

Once the feature vector databases are prepared for all the database images system is ready to face the query image and then comparison takes place. Feature vector for the query image will be extracted and compared with all the database image feature vectors by means of similarity measure. There are various similarity metrics available to compare two images. Most commonly used similarity metric in the CBIR systems is Euclidean distance [16-19]. Here we have not limited it to Euclidean distance (ED), but also have used two more distance measures along with it , namely Absolute distance (AD) and Cosine Correlation distance (CD) [25][26]. Once the distance will be calculated between query and database image features; it will be sorted in ascending order. Then we have to select the images which are close to query based on the distances sorted (from min to max). Following equations 4, 5 and 6 are representing the distance measures ED, AD and CD respectively

Euclidean Distance	Absolute Distance	Cosine Correlation Distance
$D_{QI} = \sqrt{\sum_{i=1}^{n} \left\|(FQ_i - FI_i)\right\|^2}$ (4)	$D_{QI} = \sum_{1}^{n} \left\|(FQ_I - FI_I)\right\|$ (5)	$\frac{\langle D(n) \| Q(n)\rangle}{\sqrt{[\langle D(n) \| D(n)\rangle \langle Q(n) \| Q(n)\rangle]}}$ Where D(n) and Q(n) are Database and Query feature Vectors resp. (6)

IV. PERFORMANCE EVALUATION PARAMETERS

Performance evaluation is compulsory step to be followed after designing and implementing any new system. In CBIR systems, it is essential to check and evaluate the system's response and behaviour because of various different user expectations from the CBIR system. By taking these expectations into account we have tried to evaluate our proposed system by means of three parameters namely Precision Recall Cross over Point (PRCP), LS(Longest String), LSRR(Length of String to retrieve all Relevant) and are defined as follows.

A. PRCP

PRCP gives the cross over point of two most commonly used parameters precision and recall defined in equations 7 and 8 respectively. Taking cross over point of precision and recall indicates the idealness of the system in very precise way. PRCP =1 is indication of the ideal CBIR system, whereas PRCP =0 indicates the worst case performance of CBIR.

$$\textbf{Precision} = \frac{\textbf{Number of Relevant Images Retreived}}{\textbf{Total Number of Images Retreieved}} \quad (7)$$

$$\textbf{Recall} = \frac{\textbf{Number of Relevant Images Retreived}}{\textbf{Total Number of Relevant Images in Database}} \quad (8)$$

B. Longest String(LS)

It identifies the continuous string of relevant images from sorted set of distances. The maximum continuous string of images is then selected as LS parameter. The distances are sorted in ascending order e.g distance of query with all 2000 database images; this is done separately for each color result i,e R, G and B results. Only one maximum LS have been selected from these three color results set. We also have kept track that the final LS is coming from which color result; and this is one way of checking the role of these three colors in the system.

C. Length of String to Retrieve all Relevant (LSRR)

This parameter works on identifying and analysing the response time of the system to recall all images relevant query from the database. Input for this parameter is same i.e set of images (2000) sorted according to distances sorted in ascending order. It is collecting all images available in the database which are relevant to query image; and here LSRR comes in picture which keeps track that how long the system travels to collect all images. The minimum is the traversal, best is the performance and the long it travels indicates the worst it performs. Minimum LSRR can be defined as the traversal length where all query relevant images are extracted as initial continuous string. As users are interested in minimum LSRR; selecting minimum LSRR among results obtained separately for R, G and B colors. Here also we kept track that which color is performing better among three.

V. RESULTS AND DISCUSSION

Approaches proposed in this paper are experimented with database of 2000 BMP images having 20 classes. Sample image from each class is shown below in Fig.6. In this work bins approach is designed and implemented with two partitioning techniques LP and CG. Multiple feature vector databases are prepared based on the types of feature vectors with respect to R, G and B colors and four moments namely Mean, Standard deviation (STD), Skewness(SKEW) and Kurtosis (KURTO). System is tested with all these databases using same set of query images. Total 200 randomly selected images includes 10 from each of the 20 classes are used as queries.

Fig.6. Sample Images from 20 classes in Database

Once the query image is fired to the system, query feature vector will be extracted and then it will be compared with all feature vector databases by means of three similarity measures ED, AD and CD. Each of these 200 queries is executed for all three performance evaluation parameters PRCP, LS and LSRR. We have analysed and compared these results with respect to the partitioning CG and LP, R, G, B colors and the distance measures used. Result obtained for each parameter for each type of feature vector based on moments is shown in following tables.

A. Precision Recall Cross Over Point (PRCP)

Table I. PRCP: MEAN

	ED		AD		CD	
SM	CG	LP	CG	LP	CG	LP
R	4827	5244	5535	**5711**	4121	4916
G	4845	5090	5435	5370	4512	4995
B	4979	5353	5477	5487	4604	5354

Table II. PRCP: STD

	ED		AD		CD	
SM	CG	LP	CG	LP	CG	LP
R	5914	4676	**6236**	5275	5765	4816
G	5978	4469	6087	5092	6074	4570
B	5710	5136	6061	5567	5787	5155

Table III. PRCP: SKEW

	ED		AD		CD	
SM	CG	LP	CG	LP	CG	LP
R	4859	4537	5298	5100	5006	4722
G	5128	4377	5421	4986	5277	4470
B	5161	5165	**5548**	5466	5177	5169

Table IV. PRCP: KURTO

	ED		AD		CD	
SM	CG	LP	CG	LP	CG	LP
R	5965	4854	**6320**	5498	5968	5028
G	6200	4629	6268	5301	6197	4711
B	5984	5324	6188	5672	5902	5346

In the above tables form I. to IV PRCP results obtained for first four moments have been shown respectively. Each entry in the table is out of 20,000 because it is showing the total result of 200 queries executed for that parameter. Best results are indicated for LP and CG with yellow and pink color respectively. In above cases, It can be clearly noticed that CG is better in almost all cases except in the results of first moment i. e. Mean. Best results for each moment are highlighted with green highlighter. Here also it can be noticed that the best is coming from CG results. The best results obtained are **5711**, **6236**, **5548** **and** **6320** for **Mean, STD, SKEW and KURTO** respectively. According to these results we can say that precision and recall reached to **0.3** as average result of 200 query images. After analysing these results we have combined and refined them by applying OR criterion over R, G and B results. The criterion applied is defined as follows:

Criterion OR:

Image will be retrieved into final retrieval set if it is being retrieved in at least one of the three results set i.e results of R, G and B colors.

It has improved the system's performance to very good extent. Results after OR criterion are shown in following Table V.

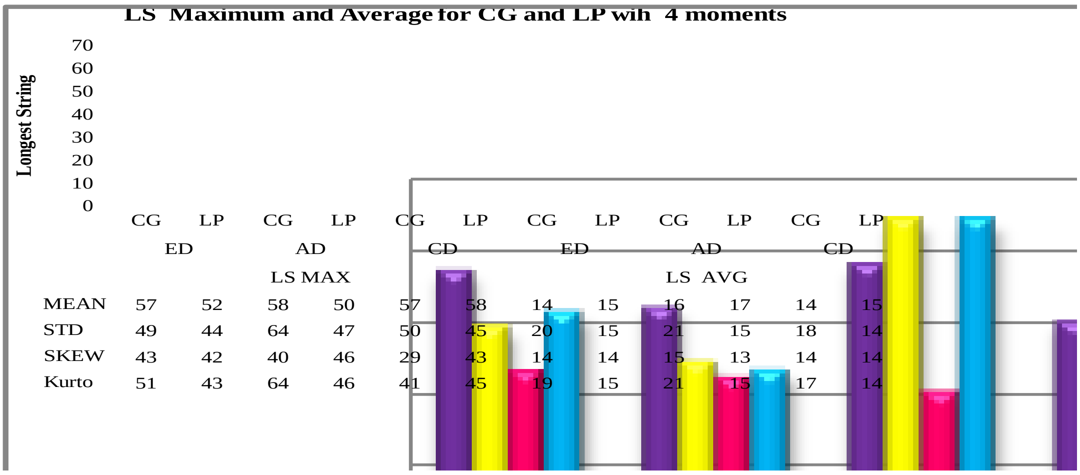
Table V. PRCP : 'R' OR 'G' OR 'B'

	ED		AD		CD	
	CG	LP	CG	LP	CG	LP
MEAN	7441	**7825**	8063	**8237**	6498	7437
STD	**9521**	7043	9491	7669	9395	7121
SKEW	9012	7005	**9106**	7557	8975	7062
KURTO	**9759**	7314	9695	7914	9518	7406

In above table we can see that, CG is better than LP even after criterion OR. The best results are highlighted for each moment and we can notice that the values are reached to good height after applying OR criterion. Now the Precision and recall are reached closed to **0.5.** One more observation in all tables I to V we found that, even moments are giving better results as compared to odd moments. Results obtained for next two parameters LS and LSRR are shown as follows.

B. Longest String (LS)

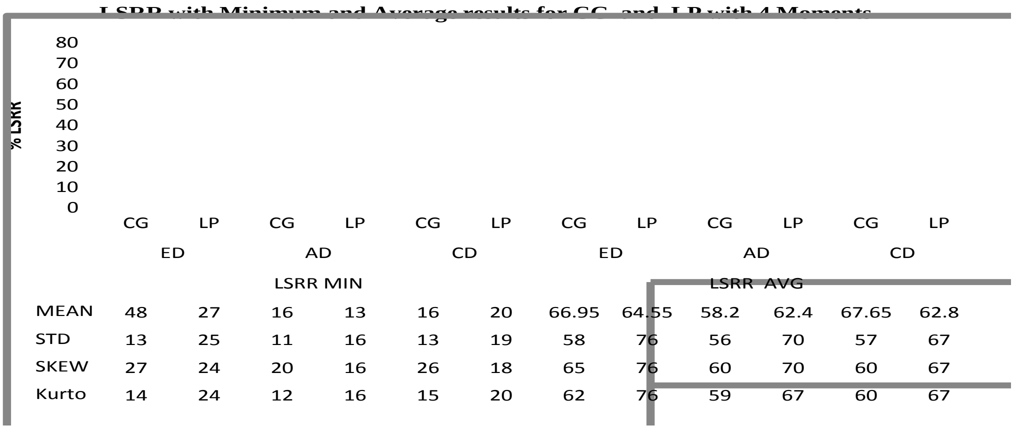
Chart 1. Maximum and Average Longest String for CG and LP with 4 moments.



	CG	LP	CG	LP	CG	LP	CG	LP	CG	LP	CG	LP
	ED		AD		CD		ED		AD		CD	
	LS MAX						LS AVG					
MEAN	57	52	58	50	57	58	14	15	16	17	14	15
STD	49	44	64	47	50	45	20	15	21	15	18	14
SKEW	43	42	40	46	29	43	14	14	15	13	14	14
Kurto	51	43	64	46	41	45	19	15	21	15	17	14

C. Length of String to Retrieve all Relevant images (LSRR)

Chart 2. Minimum and Average % LSRR for CG and LP with 4 moments.



	CG	LP	CG	LP	CG	LP	CG	LP	CG	LP	CG	LP
	ED		AD		CD		ED		AD		CD	
	LSRR MIN						LSRR AVG					
MEAN	48	27	16	13	16	20	66.95	64.55	58.2	62.4	67.65	62.8
STD	13	25	11	16	13	19	58	76	56	70	57	67
SKEW	27	24	20	16	26	18	65	76	60	70	60	67
Kurto	14	24	12	16	15	20	62	76	59	67	60	67

Section B and C are showing the results obtained for LS and LSRR parameters respectively. In both the results set we have sown the best results i.e maximum for LS and minimum for LSRR. We have also shown the results for Average of 20 best queries contains one best result from each class. Users point of view, looking maximumvalue for LS and minimum for LSRR. The best LS value obtained in maximum from all moments is **64** for CG with AD measure. In average LS the best results obtained is **21** for CG with AD measure. Similarly for LSRR best minimum LSRR as **11%** for CG with AD measure for STD. For average LSRR obtained **60%.** It suggests that minimum 11% traversal of 2000 images could collect all query relevant images available in the database and average 60% traversal can give you 100% recall. Observation of these results also points out the same thing that CG partitioning gives better results as compared to LP in most of the above cases. In these results it is found that even moments are better than odd moments.

Observing the above results for parameters PRCP, LS and LSRR; we can say that among three measures AD and CD are performing better as compared to ED measure which is most commonly used by many CBIR researchers.

VI. CONCLUSIONS

CBIR system proposed in this paper is exploring the idea for reducing the size of feature vector by partitioning the histogram using two different techniques namely CG and LP. We have worked with histograms of R, G, and B planes by partitioning them in three parts using LP and CG we obtained 27 bins. These 27 bins are used as feature vector of dimension 27. After analyzing and comparing the performances given by CG and LP based feature vectors we can comment that CG is performing far better than LP. Multiple feature vector databases are prepared and tested using 200 queries. Among these we found that feature vector based on 'Even' moments could retrieve more relevant images as compared to 'Odd' moments.

Proposed system is evaluated through three different angles using three different parameters PRCP, LS and LSRR to fulfill user's expectations. PRCP tells us that how far we are from the ideal CBIR system; here we got **0.3** as average of 200 query images when R, G, B color based results are analyzed separately. After combining these R, G and B results using OR criterion we could obtain very good retrieval where PRCP has reached closed to **0.5** as an average for 200 query images from 20 different classes. Other two parameters are also proving the system performance by giving the retrieval of continuous longest string of 64 images which are relevant to query and average LS as 21 for 20 different classes. Similarly LSRR indicates that average traversal calculated for 20 different classes is just 60% (of 2000)which gives 100 % recall for the query. Best minimum LSRR obtained is just 11% (of 2000) to get 100% recall for the given query. Analysis is done for the results for the performance given by each color(R, G and B). It is found that red and blue are dominating over green color based results. Performance analysis on the basis of similarity measure tells that AD and CD are far better than ED in almost all cases.

REFERENCES

[1]. Thomas Deselaers, Daniel Keysers, Hermann Ney, "FIRE–Flexible Image Retrieval Engine: Image CLEF 2004 Evaluation", http://www-i6.informatik.rwth-aachen.de/~deselaers/fire.html.

[2]. A. W. M. Smeulders, M. Worring, S. Santini, A. Gupta, and R. Jain. *"Content-Based Image Retrieval: The End of the Early Years."*, IEEE Transactions on Pattern Analysis and Machine Intelligence, 22(12):1349–1380, December 2000.

[3]. Gerald Schaefer, *"Content Based Image Retrieval some basics"* ww.springerlink.com/index/N5U626073X227467.pdf

[4]. Arnold W.M. Smeulders, Marcel Worring "Content-Based Image Retrieval at the End of the Early Years", IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 22, No. 12, DECEMBER 2000.

[5]. Scott Helmer, "Object Recognition with Many Local Features" Thesis For The Degree of Master of Science, The University Of British Columbia,October 2004.

[6]. Dimitri A. Lisin, Marwan A. Mattar, Matthew B. Blaschko, "*Combining Local and Global Image Features for Object Class Recognition"* Published in Proceeding CVPR '05 Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) - Workshops - Volume 03

[7]. Ashutosh Garg, Shivani Agarwal "Fusion of Global and Local Information for Object Detection" IEEE Ieeexplore. ieee.org/iel5/8091/22457/01048077.pd.

[8]. Serge Belongie, Jitendra Malik, "Shape matching and object recognition using shape contexts" IEEE Transactions on Pattern Analysis and Machine Intelligence, VOL 24 NO.24, April 2002.

[9]. Xiaoqian Xu, Dah-Jye Lee , "A Spine X-Ray Image Retrieval System Using Partial Shape Matching", IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 12, NO. 1, JANUARY 2008.

[10]. Young Deok Chun, Sang Yong Seo, and Nam Chul Kim "Image Retrieval Using BDIP and BVLC Moments", IEEE Transactions On Circuits And Systems For Video Technology, VOL. 13, NO. 9, SEPTEMBER 2003.

[11]. Hidenori Yamamoto, Hidehiko Iwasa, Naokazu Yokoya *"Content-Based Similarity Retrieval of Images Based on Spatial Color Distributions"* Authorized licensed use limited Downloaded on April 06,2010 at 23:52:34 EDT from IEEE Xplore.

[12]. Shaila S.G and A.Vadivel, "Content-Based Image Retrieval Using Modified Human Colour Perception Histogram", Natarajan Meghanathan, et al. (Eds): ITCS, SIP, JSE-2012, CS & IT 04, pp. 229–237, 2012.© CS & IT-CSCP 2012 DOI : 10.5121/csit.2012.2121.

[13]. Deng, Y., Manjunath, B.S., Kenney, C., Moore, M.S. & Shin, H, "An efficient colour

[14]. representation for image retrieval", IEEE Transactions on Image Processing, Vol. 10, pp140-147., 2001.

[15]. Bikesh Kr. Singh, G. R Sinha, "Content Based Retrieval of X- ray Images Using Fusion of Spectral Texture and Shape Descriptors", 2010 International Conference on Advances in Recent Technologies in Communication and Computing., 978-0-7695-4201-0/10 $26.00 © 2010 IEEE.

[16]. Sameer Antania, Rangachar Kasturia, Ramesh Jainb "A survey on the use of pattern recognition methods for abstraction, indexing and retrieval of images and video", Pattern Recognition 35 (2002) 945–965, www.elsevier.com/locate/patcog.

[17]. Yong Rui and Thomas S. Huang "Image Retrieval: Current Techniques, Promising Directions, and Open Issues", Journal of Visual Communication and Image Representation 10, 39–62 (1999)

[18]. Deb & Y. Zhang, (2004) "An overview of content-based Image retrieval techniques," Proc. on 18th

[19]. Int. Conf. on Advanced Information Networking and Applications, Vol. 1, pp59-64.

[20]. Ritendra Datta, Dhiraj Joshi, Jia Li, And James Z. Wang, "Image Retrieval: Ideas, Influences, and Trends of the New Age", ACM Computing Surveys, Vol. 40, No. 2, Article 5, Publication date: April 2008.

[21]. Jia Kebin, Lv Zhuoyi, Xie Jing, Liu Pengyu, Zhu Qing, "An Effective and Fast Retrieval Algorithm for Content-based Image Retrieval" Congress on Image and Signal Processing, Volume 5, May 2008.

[22]. Yi Tao, W.I. Grosky *"Spatial Color Indexing Using Rotation, Translation, and Scale Invariant Anglograms",* Multimedia Tools and Applications, 15, 247–268, 2001, Kluwer Academic Publishers. Manufactured in The Netherlands 2001.

[23]. Dr. H. B. Kekre, Kavita Sonawane, "Feature Extraction in the form of Statistical Moments Extracted to Bins formed using Partitioned Equalized Histogram for CBIR", IJEAT, ISSN: 2249 – 8958, Volume-1, Issue-3, February 2012

[24]. Dr. H. B. Kekre, Kavita Sonawane, "Bin pixel Count, mean and total of intensities extracted from partitioned equalized histogram for CBIR", International, IJEST, ISSN : 0975-5462 Vol. 4 No.03 March 2012

[25]. Dr. H. B. Kekre, Kavita Sonawane, "Linear Equation in Parts as Histogram Specification for CBIR Using Bins Approach", International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 4, Issue 4 (October 2012), PP. 73-8.

[26]. Dr. H. B. Kekre, Kavita Sonawane, "Bins Formation using CG based Partitioning of Histogram Modified Using Proposed Polynomial Transform 'Y=2X-X2'for CBIR", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 3, No. 5, 2011.

[27]. Dr. H. B. Kekre, Kavita Sonawane, "Performance of Histogram Modification by LOG Function for CBIR using Statistical Parameters of Bins Contents", International Journal of Electronics Communication and Computer Engineering Volume 3, Issue 6, ISSN (Online): 2249–071X, ISSN (Print): 2278–4209.

[28]. Dr. H. B. Kekre, Kavita Sonawane, "Effect of Similarity Measures for CBIR Using Bins Approach", International Journal of Image Processing (IJIP), Volume (6) : Issue (3) : 2012.

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