STATISTICAL PARAMETERS BASED FEATURE EXTRACTION USING BINS WITH POLYNOMIAL TRANSFORM OF HISTOGRAM

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ABSTRACT

This paper explores the new idea of feature extraction in terms of statistical parameters using the bins formed by dividing the modified histogram of an image plane using Centre of Gravity. The special polynomial function used to modify the histogram is '$y=2x-x^2$' which modifies the original histogram such that it improves the image by shifting the pixels from lower intensity level to higher intensities. Efficient use of this technique is demonstrated using the database of 2000 BMP images includes 100 images from each of the 20 different classes namely: Flower, Sunset, Mountain, Building, Bus, Dinosaur, Elephant, Barbie, Mickey, Horse, Kingfisher, Dove, Crow, Rainbow rose, Pyramid, Plate, Car, Trees, Ship and Waterfall. In feature extraction process the image is separated into R, G, and B planes. For each plane the original and modified histogram using polynomial transform is obtained. These original and modified histograms are partitioned into two parts using centre of gravity (CG). Based on this partitioning we could form 8 bins. As we have three planes(R, G and B)and each one is divided into two parts so that (2^3) 8 possible combinations are obtained for each pixel of the image to be counted into that specific 'BIN'. Feature extraction process is carried out at the beginning and the feature vector databases are prepared for the database of 2000 images. Based on the four statistical parameters calculated for R, G and B contents of each bin: Mean, Standard Deviation, Skewness and Kurtosis; we could prepare four separate feature vector databases for each color. Feature vector extraction process is followed by application of three similarity measures namely Cosine Correlation distance (CD), Euclidean distance(ED), and Absolute distance (AD). Performance of the system with respect to all factors i.e. role of feature vector, role of modified histogram as compared to original histogram and the role of similarity measures is evaluated using three parameters Precision Recall Cross over Point(PRCP), LSRR(Length of string to Retrieve all Relevant images) and 'Longest String'. We have proved that efficient CBIR system can be designed and used based on simple statistical parameters extracted from bins of modified histogram. Polynomial modification of histogram gives far better performance as compared to original histogram. Performance of Absolute distance and Cosine correlation distance is far better than the conventional Euclidean distance.

KEYWORDS: *Polynomial Transform, Modified Histogram, Centre of gravity, Mean, Standard deviation, Skewness, Kurtosis, CD, ED, AD, PRCP, LSRR, 'Longest String'.*

I. INTRODUCTION

This paper introduces new feature extraction method for content based image retrieval which makes use of statistical parameters obtained from bins of modified histogram with polynomial transform. Content Based Image Retrieval techniques are the methods to retrieve the images of user interest from large image databases using the image contents or say image descriptors. The image contents can be represented in various formats using different ways to extract and analyze and describe them. The most common classification of image descriptors is local and global image descriptors. The former category includes texture histogram, color histogram; color layout of the whole image, and features selected from multidimensional discriminant analysis of a collection of images [1], [2], [3], [4]. While color, texture, and shape features for sub images, segmented regions [5], or interest points [6] belong to the latter category. Important factors behind searching effective techniques for feature extraction are the space requirement to store the image features, time requirement for compare them to find closest match between the images or to achieve high accuracy in retrieval. The main issue in design of any CBIR is the method to extract the images features. Various researchers have found effective ways to extract image contents from spatial and frequency domain. Frequency domain techniques may generate compact features easily by utilizing the energy compaction properties of the various transforms.[7], [8], [9], [10]. Image features like histograms – local corresponding to regions or sub-image or global , color layouts, gradients, edges, contours, boundaries & regions, textures and shapes have been reported in the literature[11], [12], [13], [14].The color feature is one of the most widely used visual features in image retrieval. It is relatively robust to background complication and independent of image size and orientation [15], [16]. Histogram is one of the simplest image features which is invariant to translation and rotation about viewing axis. Statistically, it denotes the joint probability of the intensities of the three color channels. One drawback of histograms is that lack of spatial information of the pixels, many histogram refinement techniques have been reported in the literature [17], [18], [19], [20]. In this paper we are working with the simple histogram based technique to extract the features. We have used simple polynomial transform to modify the histogram such that pixels form lower intensities will be shifted towards high intensities. The very first step we performed is separation of an image into R, G and B planes and for each plane the modified histogram is obtained. These histograms are partitioned into equal parts using the CG i.e centre of gravity so that the image planes will be divided equally in two parts such that each part has same mass. Using this partitioning of three planes we could form eight bins out of it. Each of the eight bins will have the count of the pixels falling in the particular range of intensities. Eight bins obtained for each image representing that image and used to compare it to find out the match. As per the literature survey taking all histogram bins (256) directly or selecting the histogram bins for comparing feature vectors is time consuming and tedious task followed the researchers [2], [20], [21], [22]. But using our partitioning technique we could form 8 bins which are greatly reducing the size of the feature vector to just 8 components. This saves the computational time taken by the system to compare two feature vectors. This color distribution obtained as count of pixels is then expressed using the statistical parameters as first four moments Mean, Standard deviation (STD), Skewness(SKEW) and Kurtosis (KURTO). These moments are used as separate type of feature vector for (each color (R, G and B) named as MEAN, STD, SKEW and KURTO [23], [24]. Comparison process is carried out using three similarity measures Cosine correlation, Euclidean and Absolute distance measures i.e CD, ED and AD respectively[25], [26], [27], [28]. This system is tested for all types of feature vectors for original and modified histogram with respect to each distance measure for the database of 2000 BMP images using 200 query images. Performance of each variation used in different stage of this CBIR is evaluated using three parameters namely PRCP (Precision Recall Cross over Point), Longest String and LSRR (Length of the String to Retrieve all Relevant)[29], [30], [31], [32]. This presentation is organized as follows: Section II describes the feature extraction process with implementation details. Section III explains process of Comparing query with database images and also gives brief description of the evaluation parameters used. Section IV discusses in detail about the results obtained for each parameter which is followed by the Conclusion Section V.

II. FEATURE EXTRACTION

The pre-processing part of the system is preparation of feature vector databases for 2000 images in the database before the query enters into the system. We have prepared multiple feature vector databases based on the type of the feature vector. Types differ based on the color and moments. i.e for each color R, G and B we have four feature vector databases as one for each moment. i.e Mean, STD, Skew and Kurto. Same set of feature vectors are obtained for both original and modified histogram and their performance is analysed and compared using the same set of parameters.

2.1. Histogram Modification and CG partitioning

Once the image is selected for feature extraction it will be separated into R, G and B planes to handle each color information separately. For each color we have obtained its original histogram which is modified using the polynomial transform given in the Equation1 and Figure 2. We can see that after modifying how the histogram is shifted towards high level intensities and in the modified image plane the image details can be seen clearly. Figure 3 shows the green plane with original and its modified histogram. Equation 2 shows the partitioning function used. Figure 4 a. and 4b. are showing the original and modified histogram with CG partitioning respectively.

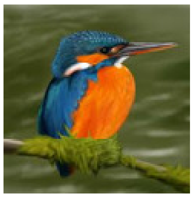

Figure 1: Kingfisher Image

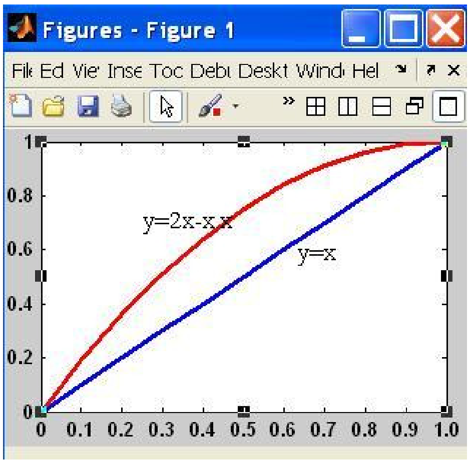

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Figure 2: Polynomial Transform $y = 2x-x^2$

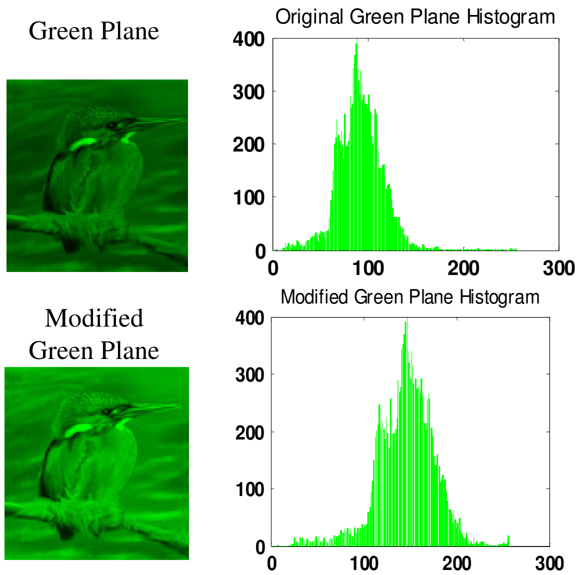


Figure 3: Green plane with Original and Modified histogram

$$y = \left(2x - x^2\right) \quad (1)$$

Where

$$y = 0;\ IF\ \ x = 0$$

$$y = 1;\ IF\ \ x = 1$$

$$y > x\ \ for\ \ 0 < x < 1$$

As shown in above figure each image plane is modified using the given polynomial function and further it is divided into two partitions by calculating the centre of gravity CG given in equation 2.

$$CG = \left[\frac{(L_i W_i + L_{i+1} W_{i+1} + \cdots + L_n W_n)}{\sum_{i=1}^{n} W_i}\right] \quad (2)$$

Where L_i is intensity Level and W_i is no of pixels at L_i

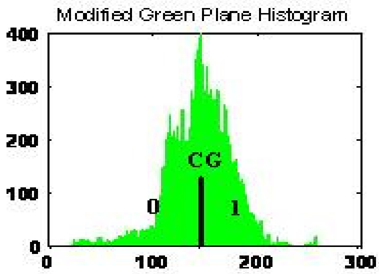


Figure 4: Green Plane Modified histogram with CG partitioning

Once this partitioning is done the partitions are identified using the id 0 and 1as shown in Figure 4. This actually helps in generating the eight bin addresses.

2.2. Bins Formation

The partition ids are giving the identification of the intensities in that particular range. Now when the feature extraction process comes at this stage, system checks the R, G and B intensity of the pixel under process and finds out in which partition of the respective R, G and B modified histogram it falls. Based on this data the id will be assigned to that pixel in three bits for three colors. This three colors and two partitions are generating 2^3 combinations which are nothing but our 8 bin addresses. For each pixel of the image this three bit address will be identified and that pixel will be then counted into that particular bin. e.g if the pixel R, G and B color is falling in the partitions 1, 0, and 1 respectively then it will be counted into 'Bin 5'. Same process will be applied to each pixel of the image and set of 8 bins from 000 to 111 having the distributed count of all image pixels is obtained. These bins are further used to hold the color distribution of the pixel count and this is expressed or represented using the mathematical foundation that is statistical absolute centralize first four moments as explained below in section 2.3.

2.3. Statistical parameter based Feature Extraction

Once the eight bins are ready with count of pixels we have directed them to have the first four absolute moments namely Mean, Standard Deviation, Skewness and Kurtosis. First two moments are giving location and variability of the color or say intensity levels counted into each bin. Third and fourth moments provide some information about the appearance of the distribution of grey levels or can say provides information about the shape of the color distribution. These are calculated for the pixel count of each bin for R, G and B colors separately using the equation 3, 4, 5 and 6 respectively. This gives the four types of feature vectors of each color. They are stored separately and multiple feature vector databases are prepared for all 2000 database images.

Mean →
$$\overline{R} = \frac{1}{N}\sum_{i=1}^{N} R_i \quad (3)$$

Skewness →
$$R_{SK} = \frac{1}{N}\sqrt[3]{\sum_{i=1}^{N}(R_i - \bar{R})^3} \quad (5)$$

Standard deviation →
$$R_{SD} = \frac{1}{N}\sqrt{\sum_{i=1}^{N}\left(R - \overline{R}\right)^2} \quad (4)$$

Kurtosis →
$$R_{KU} = \frac{1}{N}\sqrt[4]{\sum_{i=1}^{N}(R_i - \bar{R})^4} \quad (6)$$

Where $\overline{R}$ is Bin_Mean_R in eq. 3, 4, 5 and 6.

Total 12 feature vector databases are obtained for 3 colors with four moments. Each of these databases is tested using three similarity measures and the comparison of query image feature vector is facilitated with database image feature vectors.

III. COMPARISON PROCESS AND PERFORMANCE EVALUATION PARAMETERS

3.1 Application of Similarity Measure

In all content based image retrieval systems image contents are extracted using various new methods and represented as feature vectors so that comparing images will be easy in term of space and computational complexity. Computational complexity of CBIR system also depends on the significant factor called similarity measure used to compare these feature vectors. Its complexity and effectiveness can be determined on the basis of time taken by the measure to compare two image features. It also determines the closeness or similarity between feature vectors. Here we have used three similarity measures Cosine correlation distance, Euclidean distance and Absolute distance given in equation 7, 8 and 9 respectively.

Cosine Correlation Distance

$$\frac{(D(n)) \bullet (Q(n))}{\sqrt{\left[|D(n)|^2 \, |Q(n)|^2 \right]}} \tag{7}$$

Where D(n) and Q(n) are Database and Query feature Vectors resp.

Euclidean Distance :

$$D_{QI} = \sqrt{\sum_{i=1}^{n} \left| (FQ_i - FI_i) \right|^2} \tag{8}$$

Absolute Distance:

$$D_{QI} = \sum_{1}^{n} \left| (FQ_I - FI_I) \right| \tag{9}$$

Each of these measures has got its own property. We have analyzed that Euclidean distance varies with variation in the scale of the feature vector but Cosine correlation distance is invariant to this scale transformation which brings positive change in the results in terms of similarity retrieval. Among all three similarity measures absolute distance is very simple to implement and taking less computational time to compare two images. Results with respect to each distance measure are compared against same set of query images so that their performance can be compared and evaluated.

3.2 Performance Evaluation Parameters

We have used three parameters to evaluate the performance of this system namely PRCP (Precision Recall Cross Over Point), Longest String and LSRR.

PRCP: This parameter is designed on basis of conventional parameters Precision and Recall defined as:

Precision: Precision is the fraction of the relevant images which has been retrieved (from all retrieved):

$$\text{Precision} = A / B \tag{10}$$

Where, A is "Relevant retrieved" and
B is "All Retrieved images"

Recall: Recall is the fraction of the relevant images which has been retrieved (from all relevant):

$$\text{Recall} = A / D \tag{11}$$

Where, A is "Relevant retrieved" and
D is "All Relevant images in Database"

Precision is the measure of 'Accuracy' and Recall measures the 'Completeness' of the CBIR system. When we take a cross over point of precision and recall it is termed as PRCP. When this point PRCP is '1' it indicates that all retrieved images are relevant to query and also that all relevant images are retrieved from database. Thus it tells us about how far we are from the ideal system so that we can compare the performance of different systems using this measure.

We have calculated the distance between the query image and all database feature vectors (2000). These distances are sorted in ascending order from minimum to maximum distance. Here we are searching for the images similar to query from first 100 images. As each class has got 100 images into database we are taking the count of relevant from first 100 we got this result as cross over point of precision and recall where both will be equal.

Longest String: Longest string searches for the longest continuous string of images similar to query from the distance set sorted in ascending order from 1 to 2000. From this it selects the maximum longest string as final result which is always desired by the CBIR user.

LSRR: LSRR is the Length of string to be traversed to retrieve all relevant. This parameter determines the closeness of the similarity in terms of length required to be traversed of the sorted distances to collect all images relevant to query from database i.e 100 in our case. We can say that it gives the measure of length to make recall 1.

Figure 5: 20 Sample Images from database of 2000 BMP images having 20 classes

IV. RESULTS AND DISCUSSION

Once the feature vector databases are ready and the similarity measures are selected system will wait for the query to be fired by the user. When user enters the query image, system calculates the feature vector for it in the same way it has done for all database images. Using this query feature vector system enters into the stage of applying the similarity measure where query and database image feature vectors will be compared and images similar to query will be retrieved by the user. CBIR system based on the feature extraction in the form of statistical parameters using bins formed by partitioning the modified histogram using CG is experimented with the database and query image details given below.

4.1. Database and Query Images

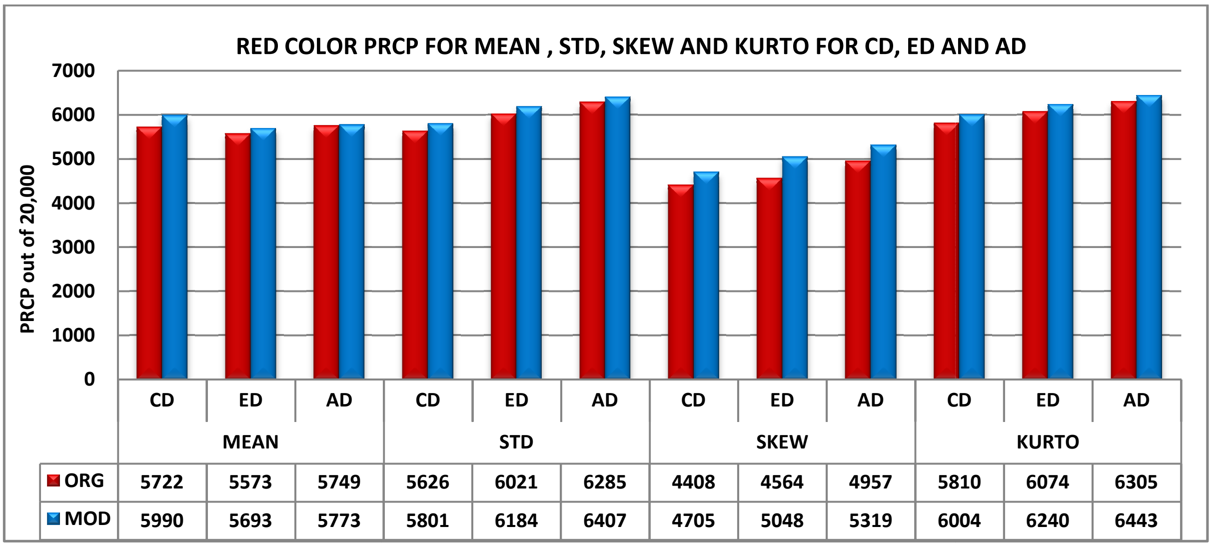
Database used for analyzing performance of the newly designed approaches is consist of 2000 BMP images from 20 different categories includes Flower, Sunset, Mountain, Building, Bus, Dinosaur, Elephant, Barbie, Mickey cartoon, Horses, Kingfisher, Dove, Crow, Rainbowrose, Pyramid, Food plante, Car, Trees, Ship and Waterfall. Each category has got 100 images. One sample image from each class is taken and shown in Figure 5. Ten (10) query images are selected randomly from each class. We have experimented this system with 200 query images and same set of queries are fired to all feature vector database so that their performance can be compared and evaluated.

4.2. Results obtained for parameter PRCP

All results shown and discussed are executed with 10 query images from each class i.e we have run 200 images for all feature vector databases discussed based on original and modified histograms.

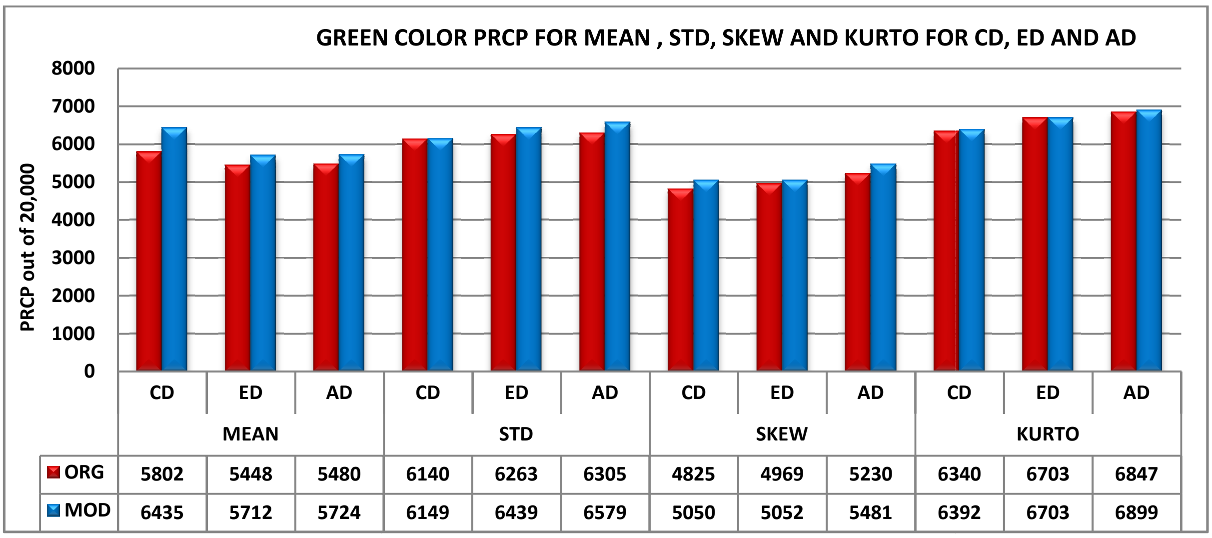
Chart 1, 2 and 3 are showing the results obtained for Red, Green and Blue color feature vectors respectively in terms of four moments MEAN, STD, SKEW and KURTO using three similarity measures CD, ED and AD. Each value plotted in the charts is total PRCP obtained for set of 200 queries i. e. Each value obtained is out 20,000.We can observe in all three charts that histogram modified using the given polynomial function performs better in all the cases as compared to original histogram. We can see that among four moments Mean, STD and KURTO are performing better as compared SKEW and among these three STD and KURTO is better as compared to MEAN. We can say that even moments are better than odd moments for all results in Charts 1, 2 and 3. Comparing the distance measure in all three cases we found CD and AD are better as compared to ED. Over all observation of these charts gives us the idea that shifting the original histogram's low level intensities towards high level intensities brings positive change in the image and improves the retrieval performance too. After the analysis of these results obtained separately for R, G and B colours we found that based on the color contents of the images best result given by each color is different and here we thought of combining them so that the best result from each of the three colors can be selected and final retrieval of images can be improved. This is achieved by applying OR operation over the results obtained for R, G and B separately and the results obtained are shown in section 4.3.

Chart1. Red Color Results for PRCP with CD, ED and AD



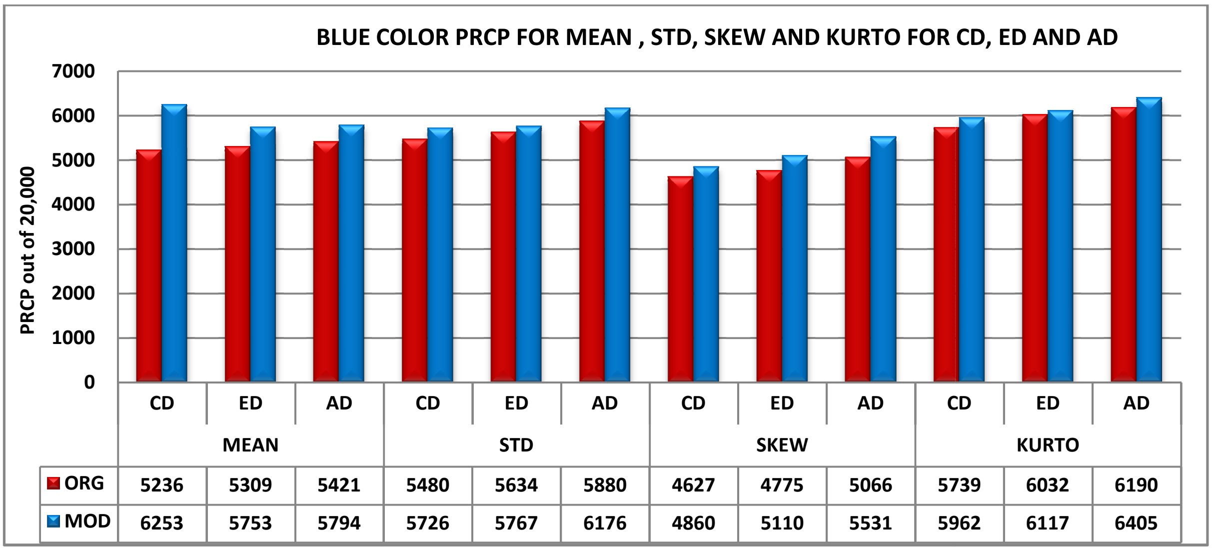
Remark: Modified Histogram is better as compared to Original for 12 out of 12 cases

Chart2. Green Color Results for PRCP with CD, ED and AD



Remark: **Modified Histogram is better as compared to Original for 12 out of 12 cases**

Chart3. Blue Color Results for PRCP with CD, ED and AD

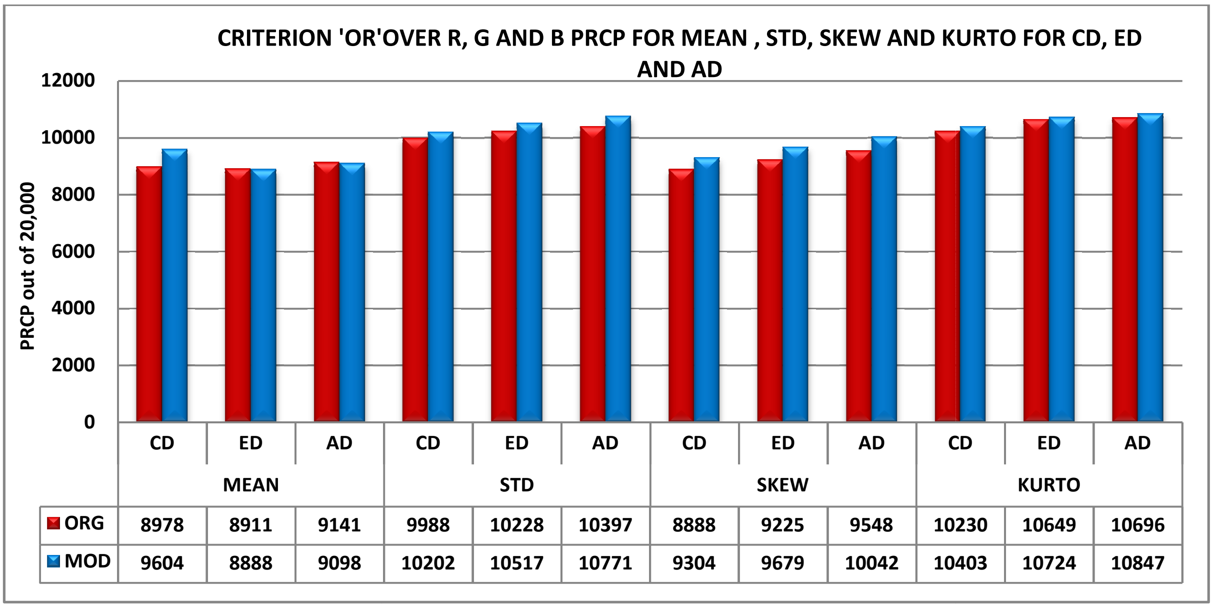


Remark: **Modified Histogram is better as compared to Original for 12 out of 12 cases**

4.3. Application of 'Criterion OR' : 'R' OR 'G' OR 'B' PRCP Results.

Results shown in Charts 1, 2, 3 are combined using OR operation. This combined result of R, G and B color obtained for PRCP parameter for four moments Mean, Standard deviation, Skewness and Kurtosis using CD, ED and AD is shown in Chart 4 below. We can observe in chart 4 that final retrieval in terms of PRCP is improved to very good height. Previously we observed these values got maximum height till 6000 only (shown in charts 1, 2 and 3). It has reached to 11,000 after applying OR criterion which is good achievement in our results. One more observation is that for even moments we achieved best results for parameter PRCP.

Chart4. Results obtained for Criterion OR over R, G, and B PRCP with CD, ED and AD

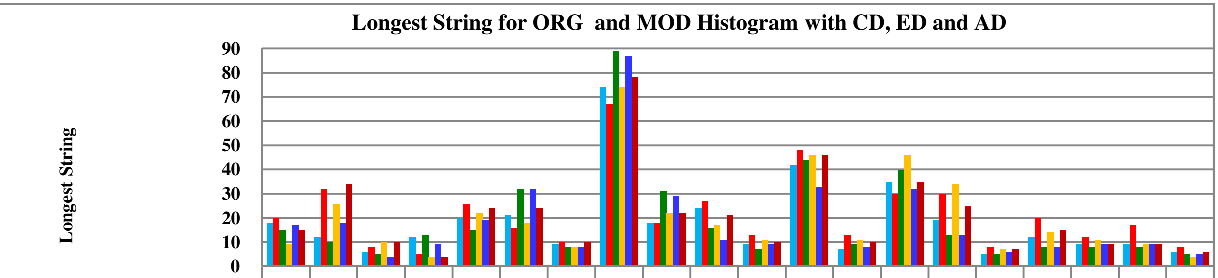


Remark: **Modified Histogram is better as compared to Original for 10 out of 12 cases**

4.4. Results obtained for parameter Longest String

All results shown below in Charts 5, 6, 7 and 8 are for longest string parameter for four moments Mean, Standard deviation, Skewness and Kurtosis respectively. Results obtained are compared for original and modified histogram with respect to each similarity measure for all 20 classes. We can observe in the charts that MEAN is giving best result among all moments. After that STD and KURTO are in good range as compared to SKEW. The best performance is achieved for class Barbie for all the cases which can be noticed easily in all charts from 5 to 8. Here also among three distance measures CD and AD performing better as compared to ED in most of the cases. Last column bars in all the four charts are representing the AVG i.e average of 20 queries maximum longest string result. For Mean we got longest string 20 as average result for 20 queries from 20 different classes which is quite good achievement in this field. Next for STD, SKEW and KURTO we obtained around 19, 14 and 18 as the average longest string respectively. In all the cases for all charts modified histogram is giving better performance as compared to original histogram.

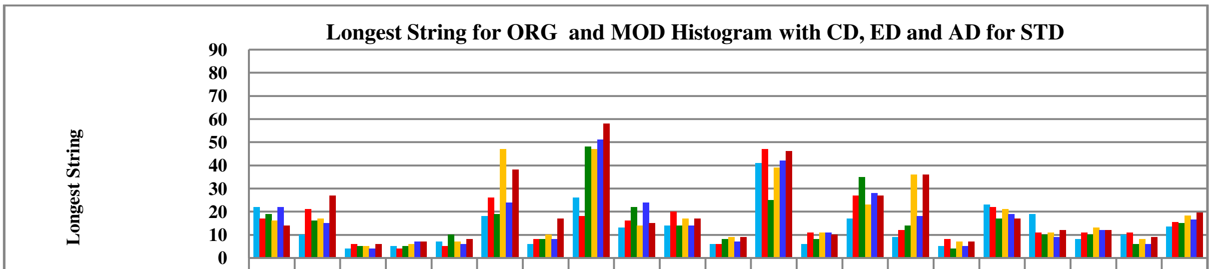
Chart 5. Maximum Longest String for MEAN (ORG and MOD Histo) with CD, ED and AD



	Flower	Sunset	Mountain	Building	Bus	Diansour	Elephant	Barbie	Mickey	Horses	Kingfisher	Dove	Crow	Rainbowrose	Pyramids	Plates	Car	Trees	Ship	Waterfall
MEAN CD ORG Longest	18	12	6	12	20	21	9	74	18	24	9	42	7	35	19	5	12	9	9	6
MEAN CD MOD Longest	20	32	8	5	26	16	10	67	18	27	13	48	13	30	30	8	20	12	17	8
MEAN ED ORG Longest	15	10	5	13	15	32	8	89	31	16	7	44	9	40	13	5	8	8	8	5
MEAN ED MOD Longest	9	26	10	4	22	18	8	74	22	17	11	46	11	46	34	7	14	11	9	4
MEAN AD ORG Longest	17	18	4	9	19	32	8	87	29	11	9	33	8	32	13	6	8	9	9	5
MEAN AD MOD Longest	15	34	10	4	24	24	10	78	22	21	10	46	10	35	25	7	15	9	9	6

Remark: Modified Histogram is better as compared to Original for 16 out of 20 cases

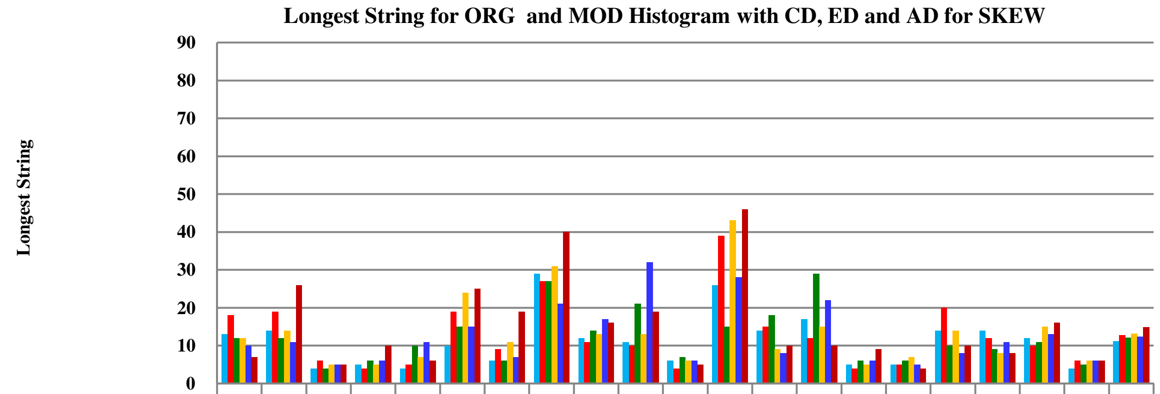
Chart6. Maximum Longest String for STD (ORG and MOD Histo) with CD, ED and AD



	Flower	Sunset	Mountain	Building	Bus	Diansour	Elephant	Barbie	Mickey	Horses	Kingfisher	Dove	Crow	Rainbowrose	Pyramids	Plates	Car	Trees	Ship	Waterfall	AVG
STD CD ORG Longest	22	10	4	5	7	18	6	26	13	14	6	41	6	17	9	5	23	19	8	10	13.4
STD CD MOD Longest	17	21	6	4	5	26	8	18	16	20	6	47	11	27	12	8	22	11	11	11	15.3
STD ED ORG Longest	19	16	5	5	10	19	8	48	22	14	8	25	8	35	14	4	17	10	10	6	15.1
STD ED MOD Longest	16	17	5	6	7	47	10	47	14	17	9	39	11	23	36	7	21	11	13	8	18.2
STD AD ORG Longest	22	15	4	7	6	24	8	51	24	14	7	42	11	28	18	5	19	9	12	6	16.6
STD AD MOD Longest	14	27	6	7	8	38	17	58	15	17	9	46	10	27	36	7	17	12	12	9	19.6

Remark: **Modified Histogram is better as compared to Original for 14 out of 20 cases**

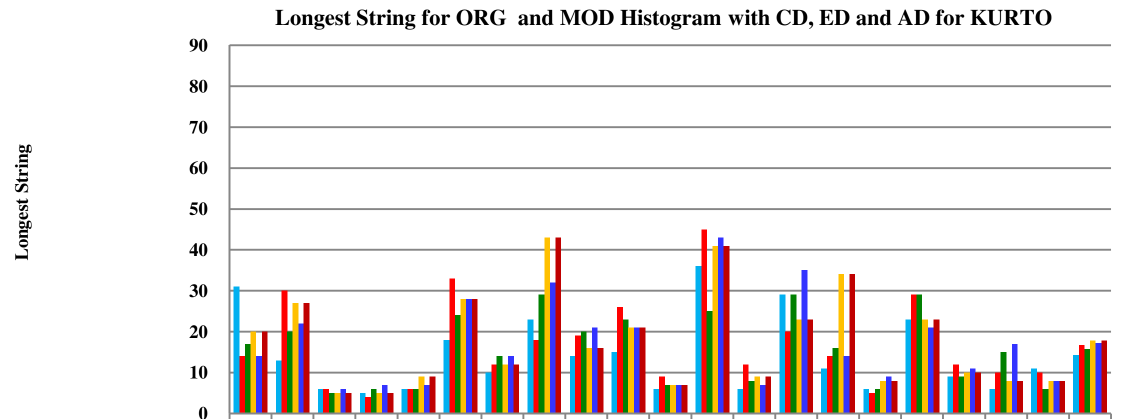
Chart7. Maximum Longest String for SKEW (ORG and MOD Histo) with CD, ED and AD



	Flower	Sunset	Mountain	Building	Bus	Diansour	Elephant	Barbie	Mickey	Horses	Kingfisher	Dove	Crow	Rainbowrose	Pyramids	Plates	Car	Trees	Ship	Waterfall	AVG
SKEW CD ORG Longest	13	14	4	5	4	10	6	29	12	11	6	26	14	17	5	5	14	14	12	4	11.2
SKEW CD MOD Longest	18	19	6	4	5	19	9	27	11	10	4	39	15	12	4	5	20	12	10	6	12.7
SKEW ED ORG Longest	12	12	4	6	10	15	6	27	14	21	7	15	18	29	6	6	10	9	11	5	12.1
SKEW ED MOD Longest	12	14	5	5	7	24	11	31	13	13	6	43	9	15	5	7	14	8	15	6	13.1
SKEW AD ORG Longest	10	11	5	6	11	15	7	21	17	32	6	28	8	22	6	5	8	11	13	6	12.4
SKEW AD MOD Longest	7	26	5	10	6	25	19	40	16	19	5	46	10	10	9	4	10	8	16	6	14.8

Remark: **Modified Histogram is better as compared to Original for 11 out of 20 cases**

Chart8. Maximum Longest String for KURTO (ORG and MOD Histo) with CD, ED and AD



	Flower	Sunset	Mountain	Building	Bus	Diansour	Elephant	Barbie	Mickey	Horses	Kingfisher	Dove	Crow	Rainbowrose	Pyramids	Plates	Car	Trees	Ship	Waterfall	AVG
KURTO CD ORG Longest	31	13	6	5	6	18	10	23	14	15	6	36	6	29	11	6	23	9	6	11	14.2
KURTO CD MOD Longest	14	30	6	4	6	33	12	18	19	26	9	45	12	20	14	5	29	12	10	10	16.7
KURTO ED ORG Longest	17	20	5	6	6	24	14	29	20	23	7	25	8	29	16	6	29	9	15	6	15.7
KURTO ED MOD Longest	20	27	5	5	9	28	12	43	16	21	7	41	9	23	34	8	23	10	8	8	17.8
KURTO AD ORG Longest	14	22	6	7	7	28	14	32	21	21	7	43	7	35	14	9	21	11	17	8	17.2
KURTO AD MOD Longest	20	27	5	5	9	28	12	43	16	21	7	41	9	23	34	8	23	10	8	8	17.8

Remark: **Modified Histogram is better as compared to Original for 11 out of 20 cases**

4.5. Results obtained for parameter LSRR

Best result of LSRR parameter is that it should be as low as possible. Minimum value obtained is indicating the minimum length required to traverse the sorted distances to recall all images relevant to query from database. All results shown below in Charts 9 , 10, 11 and 12 are showing the LSRR results obtained for 20 queries from 20 different classes for four moments MEAN, STD, SKEW and KURTO respectively using CD, ED and AD. LSRR is measured in terms of % traversal as shown in charts. We can notice that except one or two classes remaining all classes are taking below 80% LSRR to retrieve all relevant images from database which is good achievement in CBIR system. In these charts it can be observed that Classes Flower, Bus, Barbie got better results for LSRR less than 40% in MEAN, Classes Dinosaur, Bus, Horses, Trees, Pyramids and Crows got better results in STD where LSRR is below 50%. Classes Flower, Sunset, Dinosaur, Bus, Barbie. Horses, Pyramid and Crows have got good results in KURTO, here the LSRR below 50% and max till 55%. We also have plotted the Average of LSRR of 20 queries for all four parameters. Mean has got average LSRR in range 55% to 60%, STD got 50% to 60%, SKEW got LSRR around 60% and similarly average LSRR for KURTO is range 50% to 55%.

Chart9. Minimum LSRR for MEAN (ORG and MOD Histo) with CD, ED and AD

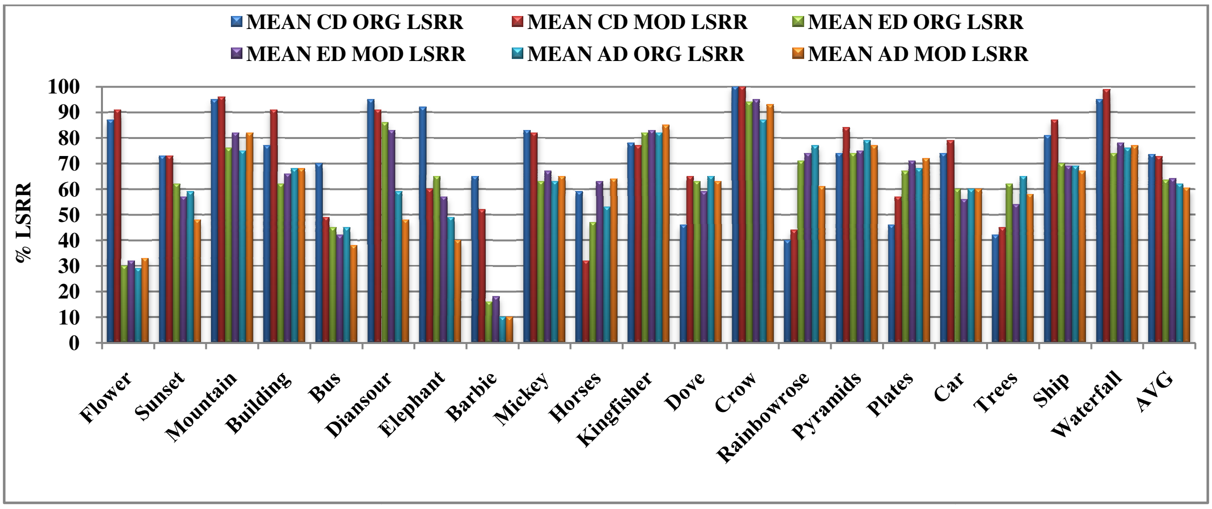


Chart10. Minimum LSRR for STD (ORG and MOD Histo) with CD, ED and AD

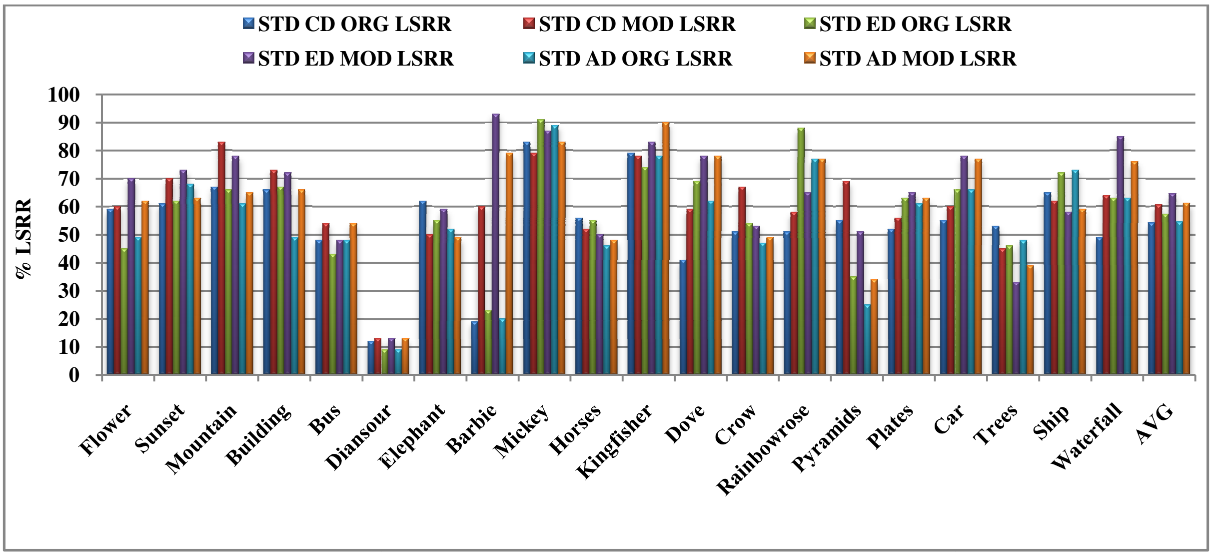


Chart11. Minimum LSRR for SKEW (ORG and MOD Histo) with CD, ED and AD

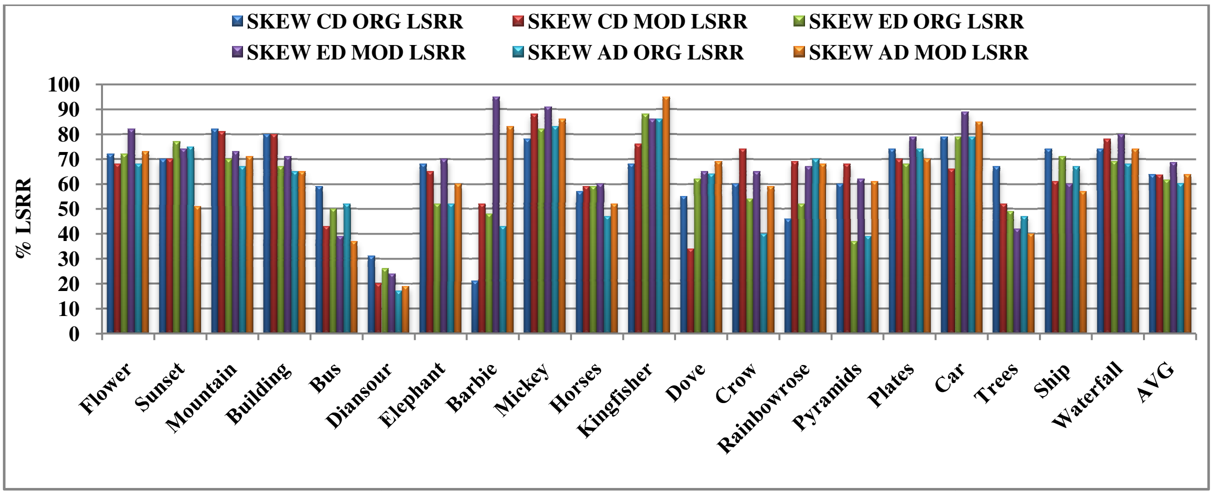
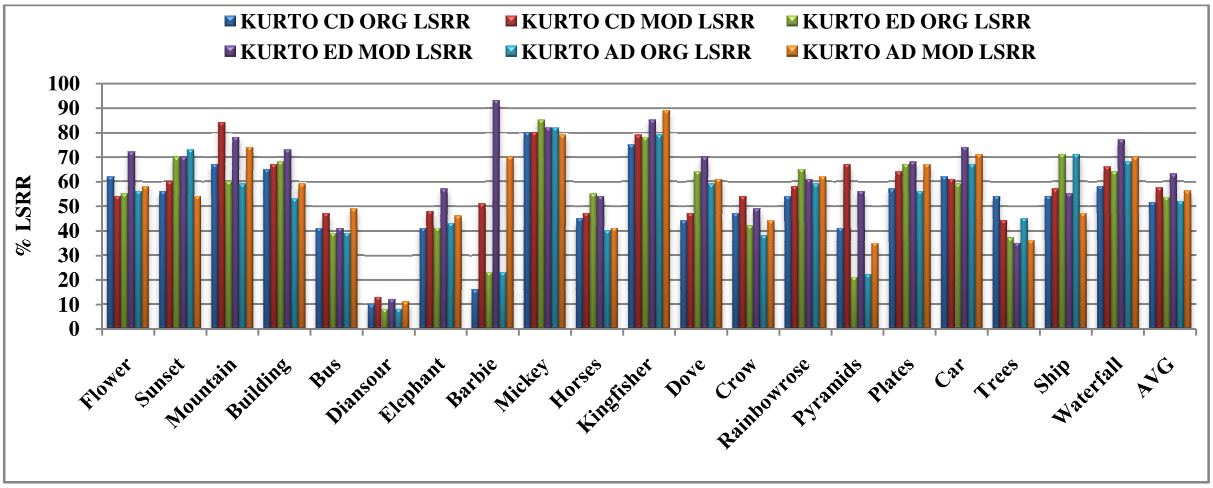


Chart12. Minimum LSRR for KURTO (ORG and MOD Histo) with CD, ED and AD



V. CONCLUSIONS AND FUTURE WORK

CBIR system discussed above is highlighting the new feature extraction method based on the statistical parameters Mean, Standard deviation, Skewness and Kurtosis extracted to eight bins form using the modified histogram and the original histogram as well. Few conclusions drawn about the response and behaviour with respect to 200 randomly selected query images fired to this system.

Images from variety of classes are considered for the experimentation and each class has achieved good retrieval in many variations used for the feature extraction and representation. When we analysed the sytem's performance for moments as feature vectors we found that 'EVEN' moments namely Standards deviation (STD) and Kurtosis (KURTO) are giving far better retrieval results as compared 'ODD' moments for all the factors considered for evaluation.

Analyzing the results obtained separately for three colors for PRCP we found the best order of performance as Green, Red and Blue color. Even for longest string and LSRR parameters we have taken the maximum and minimum respectively as the best results irrespective of the colors and we observed that whatever values we have got we checked their color factor and here also we found green and red are dominating over blue color results.

Comparing the performance or role of the similarity measures in this system we found that cosine correlation distance (CD) and absolute distance (AD) are far better than Euclidean distance (ED) in all the cases.

Now comparing the performance in terms of parameters PRCP we found the best value for KURTO which is reached to 6899 for AD green color result of modified histogram. After improved it using criterion OR we found the PRCP values reached to more than 10,000 for almost all results. The best value we found is 10847 for AD result for modified histogram. This indicates the PRCP is at **0.6** as **average of 200** queries which is better achievement compared to other CBIR systems [13], [14], [17], [18], [33], [34], [35].

For maximum longest string irrespective of three colors we found the best results as 89, 58, 46 and 45 for MEAN, STD, SKEW and KURTO features respectively. Similarly for LSRR the best value is nothing but the minimum LSRR obtained irrespective of three colors and here we found best LSRR is achieved as 60%, 54%, 60% and 51% for MEAN, STD, SKEW and KURTO features respectively which indicates that this much traversal only will give 100% recall for the given query.

Now conclusion about the main variation used in this work is we have modified the histogram using the newly designed polynomial function '$y=2x-x^2$' which is shifting the intensities from lower side to upper side is giving best performance as compared to original histogram for all the other factors except LSRR parameter. This variation has brought good improvement in the similarity retrieval as compared to the original histogram. This histogram is partitioned into two parts using CG which lead towards the formation of eight bins because of which we could greatly reduce the size of the feature vector just to 8 components as compared to 256 bins of histograms used by other researchers [20], [21], [22]. Using just 8 bins we could reduce the complexity and could save the computational time required to calculate the distance between two feature vectors.

VI. FUTURE WORK

We have planned to extend this presented work based on the modified histogram includes 8 bins as feature vector to 27 and 64 bins feature vector and some other polynomials for histogram modification are being considered.

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