Effect of Similarity Measures for CBIR Using Bins Approach

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Abstract

This paper elaborates on the selection of suitable similarity measure for content based image retrieval. It contains the analysis done after the application of similarity measure named Minkowski Distance from order first to fifth. It also explains the effective use of similarity measure named correlation distance in the form of angle 'cosθ' between two vectors. Feature vector database prepared for this experimentation is based on extraction of first four moments into 27 bins formed by partitioning the equalized histogram of R, G and B planes of image into three parts. This generates the feature vector of dimension 27. Image database used in this work includes 2000 BMP images from 20 different classes. Three feature vector databases of four moments namely Mean, Standard deviation, Skewness and Kurtosis are prepared for three color intensities (R, G and B) separately. Then system enters in the second phase of comparing the query image and database images which makes of set of similarity measures mentioned above. Results obtained using all distance measures are then evaluated using three parameters PRCP, LSRR and Longest String. Results obtained are then refined and narrowed by combining the three different results of three different colors R, G and B using criterion 3. Analysis of these results with respect to similarity measures describes the effectiveness of lower orders of Minkowski distance as compared to higher orders. Use of Correlation distance also proved its best for these CBIR results.

Keywords: Equalized Histogram, Minkowski Distance, Cosine Correlation Distance, Moments, LSRR, Longest String, PRCP.

1. INTRODUCTION

Research work in the field of CBIR systems is growing in various directions for various different stages of CBIR like types of feature vectors, types of feature extraction techniques, representation of feature vectors, application of similarity measures, performance evaluation parameters etc[1][2][3][4][5][6]. Many approaches are being invented and designed in frequency domain like application of various transforms over entire image, or blocks of images or row column vector of images, Fourier descriptors or various other ways using transforms are designed to extract and represent the image feature[7][8][9][10][11][12]. Similarly many methods are being design and implemented in the spatial domain too. This includes use of image histograms, color coherence vectors, vector quantization based techniques and many other spatial features extraction methods for CBIR [13][14][15][16][17]. In our work we have prepared the feature vector databases using spatial properties of image in the form statistical parameters i.e. moments namely Mean, Standard deviation, Skewness and Kurtosis. These moments are extracted into 27 bins formed by partitioning the equalized histograms of R, G and B planes of image into 3 parts.[18][19][20]. The core part of all the CBIR systems is calculating the distance between the query image and database images which has great impact on the behavior of the CBIR system as it actually decides the set of images to be retrieved in final retrieval set. Various

similarity measures are available can be used for CBIR [21][22][23][24]. Most commonly used similarity measure we have seen in the literature survey of CBIR is Euclidean distance. Here we have used Minkowski distance from order first to fifth where we found that performance of the system goes on improving with decrease in the order (from 5 to 1) of Minkowski distance; one more similarity measure we have used in this work is Cosine Correlation distance [25][26][27][28], which has also proved its best after Minkowski order one. Performance of CBIR's various methods in both frequency and spatial domain will be evaluated using various parameters like precision, recall, LSRR (Length of String to Retrieve all Relevant) and various others [29][30][31][32][33]. In this paper we are using three parameters PRCP, LSRR and 'Longest String' to evaluate the performance of our system for all the similarity measures used and for all types of feature vectors for three colors R, G and B. We found scope to narrate and combine these results obtained separately for three feature vector databases based on three colors. This refinement is achieved using criterion designed to combine results of three colors which selects the image in final retrieval set even though it is being retrieved in results set of only one of these three colors [11[12].

2. ALGORITHMIC VIEW WITH IMPLEMENTATION DETAILS

2.1 Bins Formation by Partitioning the Equlaized Histogram of R, G, B Planes

i. First we have separated the image into R, G and B Planes and calculated the equalized histogram for each plane as shown below.

ii. These histograms are then partitioned into three parts with id '0', '1' and '2'. This partitioning generates the two threshold for the intensities distributed across x – axis of histogram for each plane. We have named these threshold or partition boundaries as GL1 and GL2 as shown in Figure 2.

FIGURE 1: Query Image: Kingfisher

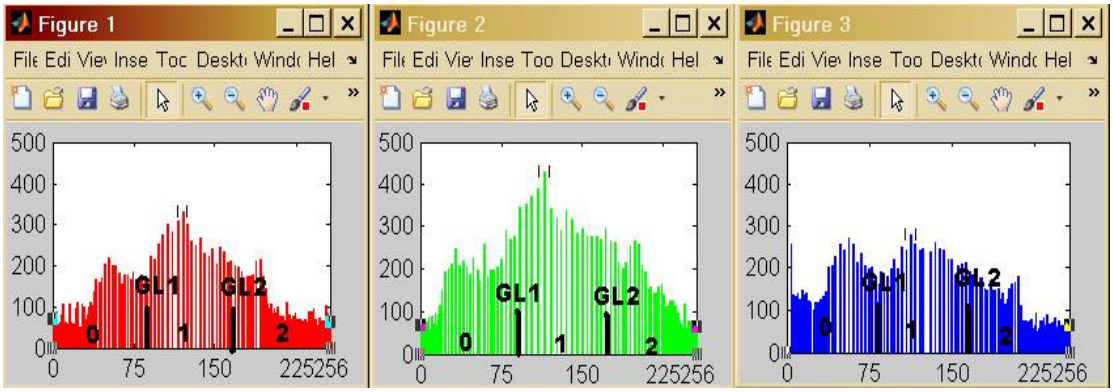


FIGURE 2: Equalized Histograms of R, G and B Planes With Three partitions '0', '1' and '2'.

iii. Determination of Bin address: To determine the destination for the pixel under process of extracting feature vector we have to check its R, G and B intensities where they fall, in which partition of the respective equalized histogram either '0','1' or '2' and then this way 3 digit flag is assigned to that pixel itself its destination bin address. Like this we have obtained 000 to 222 total 27 bin addresses by dividing the histogram into 3 parts.

2.2 Statistical Information Stored in 27 Bins: Mean, Standard Deviation, Skewness and Kurtosis

Basically these bins obtained are having the count of pixels falling in particular range. Further these bins are used to hold the statistical information in the form of first four moments for each color separately. These moments are calculated for the pixel intensities coming into each bin using the following Equations 1 to 4 respectively.

Mean	$\overline{R} = \frac{1}{N}\sum_{i=1}^{N} R_i$ **(1)**	**Skew**	$R_{SK} = \frac{1}{N}\sqrt[3]{\sum_{i=1}^{N}(R_i - \overline{R})^3}$ **(3)**
Standard deviation	$R_{SD} = \frac{1}{N}\sqrt{\sum_{i=1}^{N}(R - \overline{R})^2}$ **(2)**	**Kurtosis**	$R_{KU} = \frac{1}{N}\sqrt[4]{\sum_{i=1}^{N}(R_i - \overline{R})^4}$ **(4)**
Where $\overline{R}$ is Bin_Mean_R in eq. 1, 2, 3 and 4.			

These bins are directed to hold the absolute values of central moments and likewise we could obtained 4 moments x 3 colors =12 feature vector databases, where each feature vector is consist of 27 components. Following Figure 3 shows the bins of R, G, B colors for Mean parameter. Sample 27 Bins of R, G and B Colors for Kingfisher image shown in Figure 1.

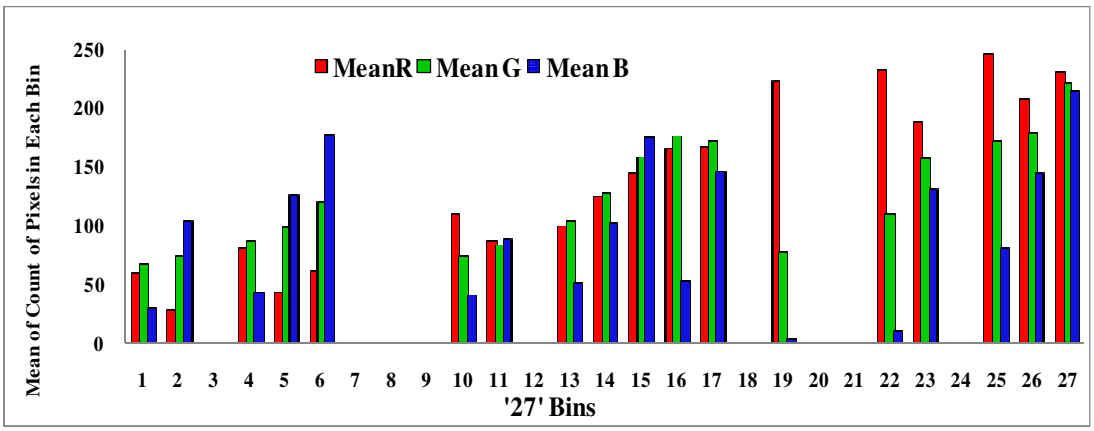


FIGURE 3: 27 Bins of R, G and B Colors for MEAN Parameter.

In above Figure 3 we can observe that Bin number 3, 7, 8, 9, 12, 18, 20, 21 and 24 are empty because the count of pixels falling in those bins is zero in this image.

2.3 Application of Similarity Measures

Once the feature vector databases are ready we can fire the desired query to retrieve the similar images from the database. To facilitate this, retrieval system has to perform the important task of applying the similarity measure so that distance between the query image and database image will be calculated and images having less distance will be retrieved in the final set. In this work we are using 6 similarity measures we named them L1 to L6, which includes Minkowski distance from order 1 to order 5(L1 to L5) and L6 is another distance i.e Correlation distance for the image retrieval. We have analyzed their performance using different evaluation parameters. These similarity measures are given in the following equations 5 and 6.

Minkowski Distance :	Cosine Correlation Distance :
$$Dist_{DQ} = \left(\sum_{I=1}^{n} \left| D_I - Q_I \right|^r \right)^{\frac{1}{r}} \quad (5)$$	$$\frac{(D(n)) \bullet (Q(n))}{\sqrt{\left[\left| D(n) \right|^2 \left| Q(n) \right|^2 \right]}} \quad (6)$$
Where r is a parameter, n is dimension and I is the component of Database and Query image feature vectors D and Q respectively.	Where D(n) and Q(n) are Database and Query feature Vectors resp.

Minkowski Distance: Here the parameter 'r' can be taken from 1 to ∞. We have used this distance with 'r' in the range from 1 to 5. When 'r' is =2 it is special case called Euclidean distance (L2).

Cosine Correlation Distance: This can be expressed in the terms of Cos θ

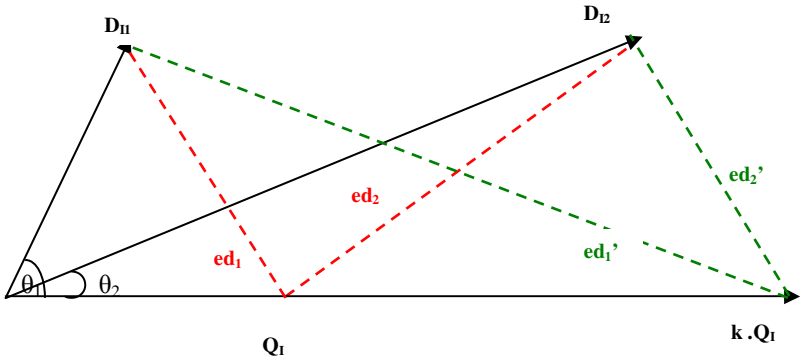


FIGURE 4 : Comparison of Euclidean and Cosine Correlation Distance

Observation: $ed_2 > ed_1$ But $ed_1' > ed_2'$

Correlation measures in general are invariant to scale transformations and tend to give the similarity measure for those feature vectors whose values are linearly related. In Figure 4. Cosine Correlation distance is compared with the Euclidean distance. We can clearly notice that Euclidean distance ed2 > ed1 between query image QI with two database image features DI1 and DI2 respectively for QI. At the same time we can see that θ1 > θ2 i.e distance L6 for DI1 and DI2 respectively for QI.

If we scaled the query feature vector by simply constant factor k it becomes k.QI ; now if we calculate the ED for DI1 and DI2 with query k.QI we got ed1' and ed2' now the relation they have is ed1' > ed2' which is exactly opposite to what we had for QI. But if we see the cosine correlation distance; it will not change even though we have scaled up the query feature vector to k.QI. It clearly states that Euclidean distance varies with variation in the scale of the feature vector but cosine correlation distance is invariant to this scale transformation. This property of correlation distance triggered us to make use this for our CBIR. Actually this has been rarely used for CBIR systems and here we found very good results for this similarity measure as compared to Euclidean distance and the higher orders of Minkowski distance.

2.4 Performance Evaluation

Results obtained here are interpreted in the terms of PRCP: Precision Recall Cross over Point. This parameter is designed using the conventional parameters precision and recall defined in equation 7 and 8.

According to this once the distance is calculated between the query image and database images, these distances are sorted in ascending order. According to PRCP logic we are selecting first 100 images from sorted distances and among these we have to count the images which are relevant to query; this is what called PRCP value for that query because we have total 100 images of each class in our database.

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

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

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

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

Further performance of this system is evaluated using two more interesting parameters about which all CBIR users will always be curious, that are LSRR: Length of String to Retrieve all Relevant and Longest String: Longest continuous string of relevant images.

3. EXPERIMENTAL RESULTS AND DISCUSSIONS

In this work analysis is done to check the performance of the similarity measures for CBIR using bins approach. That is why the results presented are highlighting the comparative study for different similarity measures named as L1 to L6 as mentioned in above discussion.

3.1 Image Database and Query Images

Database used for the experiments is having 2000 BMP images which include 100 images from 20 different classes. The sample images from database are shown in Figure 5. We have randomly selected 10 images from each class to be given as query to the system to be tested. In

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

all total 200 queries are executed for each feature vector database and for each similarity measure. We have already shown one sample query image in Figure 1. i.e. Kingfisher image for which the bins formation that is feature extraction process is explained thoroughly in section II part A and B.

3.2 Discussion With Respect to PRCP

As discussed above the feature vector databases containing feature vectors of 27 bins components for four absolute moments namely Mean, Standard deviation, Skewness and Kurtosis for Red, Green and Blue colors separately are tested with 200 query images for six similarity measures and the results obtained are given below in the following tables. Tables I to XII are showing the results obtained for parameter PRCP i.e. Precision Recall Cross over Point values for 10 queries from each class. Each entry in the table is representing the total retrieval of (out of 1000 outputs) relevant images in terms of PRCP for 10 queries of that particular class

mentioned in the first left most column of all the tables. Last rows of all the tables represent the total PRCP retrieval out of 20,000 for 200 images. When we observe the individual entry in the tables that is total of 10 queries for many classes with respect to distances L1 and L6 we have found very good PRCP values for average of 10 queries in the range from 0.5 to 0.8 which is quite good achievement. We can say that precision and recall both are reached to good height which seems difficult in the field of CBIR for large size databases. Further we have planned to improve these results not limiting to average of 10 queries but towards average of 200 queries. To obtain this refinement what we did here is we have combined and reduced the results obtained for three colors separately to single results set of three colors together by applying the criterion explained below.

Criterion: The image will be retrieved in the final set if it is being retrieved in any one color results from R, G and B.

By applying this criterion to all results obtained for three colors, four moments mentioned in the tables from I to XII we have improved the system's performance to very good extent for average of 200 queries for moments namely Mean and Standard Deviation with similarity measures L1, L6, L2 and L3 in increasing order. Results obtained are shown in Chart 1. We can see in chart that the best average for 200 queries for PRCP values we could obtained is 0.5

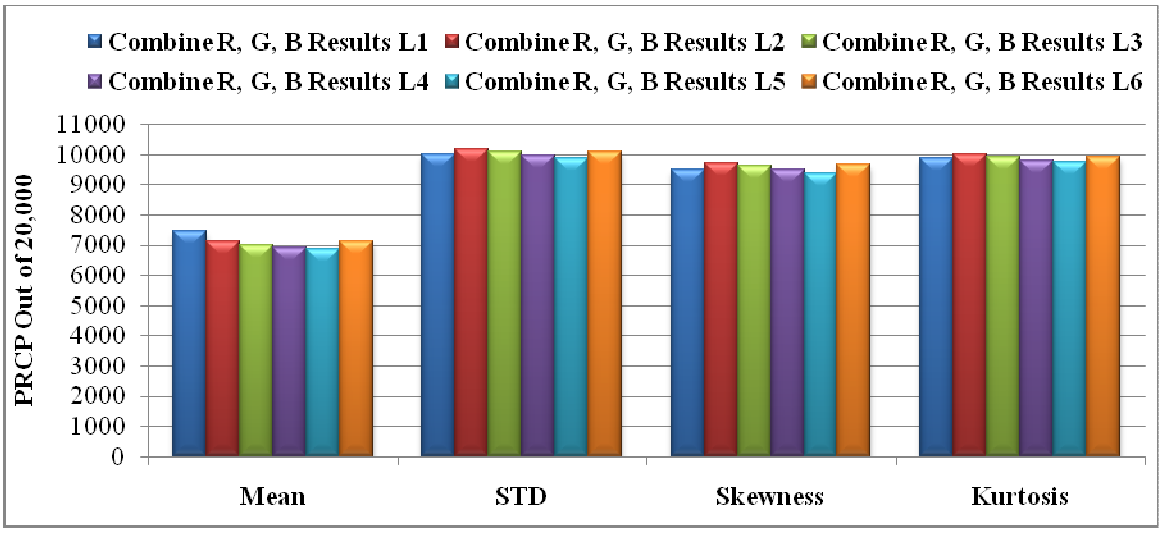
TABLE 1: PRCP FOR RED MEAN FOR L1 TO L6

CLASS	L1	L2	L3	L4	L5	L6
Flower	388	321	264	225	198	357
Sunset	764	707	603	522	461	727
Mountain	144	116	117	112	110	114
Building	177	165	161	163	161	162
Bus	512	474	439	414	407	472
Diansour	251	202	171	152	145	192
Elephant	157	128	124	119	120	133
Barbie	517	483	474	438	432	504
Mickey	305	308	301	302	300	314
Horses	285	230	194	177	173	214
Kingfisher	300	258	235	223	215	268
Dove	207	194	196	185	178	187
Crow	177	169	183	183	185	106
Rainbowrose	643	618	596	585	575	638
Pyramids	186	141	114	121	121	135
Plates	238	199	176	163	142	197
Car	134	111	104	93	91	105
Trees	283	239	231	213	206	242
Ship	327	276	256	252	244	249
Waterfall	281	214	195	190	191	205
Total	6276	5553	5134	4832	4655	5521

TABLE 2: PRCP FOR GREEN MEAN FOR L1 TO L6

CLASS	L1	L2	L3	L4	L5	L6
Flower	258	214	182	173	165	239
Sunset	714	664	633	614	610	674
Mountain	147	127	121	124	126	124
Building	189	158	149	134	133	158
Bus	421	308	247	236	223	307
Dinosaur	223	189	168	163	160	200
Elephant	176	127	107	102	103	127
Barbie	537	503	486	478	468	463
Mickey	243	225	212	205	203	237
Horses	331	303	290	279	272	310
Kingfisher	350	314	286	282	286	321
Dove	199	188	179	170	166	190
Crow	147	136	120	117	115	110
Rainbowrose	652	613	590	563	555	647
Pyramids	172	138	114	110	106	132
Plates	240	215	198	169	156	210
Car	242	247	250	252	263	272
Trees	263	221	205	185	167	227
Ship	302	289	285	270	266	294
Waterfall	226	182	175	162	157	191
Total	6032	5361	4997	4788	4700	5433

CHART 1:. Results using Criterion to combine the R, G B color results for L1 to



L6.

TABLE 3: PRCP FOR BLUE MEAN FOR L1 TO L6

CLASS	L1	L2	L3	L4	L5	L6
Flower	313	340	315	286	268	374
Sunset	542	479	474	463	455	445
Mountain	173	156	147	141	142	160
Building	170	136	114	109	100	139
Bus	433	355	346	334	327	357
Diansour	233	188	167	144	152	180
Elephant	193	176	162	145	142	183
Barbie	476	395	411	380	375	416
Mickey	217	189	173	162	161	196
Horses	297	230	192	185	183	236
Kingfisher	337	332	340	344	351	340
Dove	201	178	140	117	114	195
Crow	127	96	84	72	67	96
Rainbowrose	642	635	627	621	611	662
Pyramids	165	113	93	90	88	106
Plates	234	204	180	169	161	189
Car	162	146	138	131	132	131
Trees	251	195	165	154	153	200
Ship	307	245	203	191	180	246
Waterfall	252	176	147	135	138	187
Total	5725	4964	4618	4373	4300	5038

TABLE 4 : PRCP FOR RED STD FOR L1 TO L6

CLASS	L1	L2	L3	L4	L5	L6
Flower	312	296	279	257	243	298
Sunset	719	681	648	619	600	726
Mountain	206	208	190	172	167	199
Building	278	262	249	235	228	257
Bus	508	481	455	430	417	484
Diansour	409	430	416	416	406	366
Elephant	286	311	320	336	342	304
Barbie	485	433	386	337	320	426
Mickey	254	244	241	230	223	242
Horses	513	509	479	454	437	518
Kingfisher	417	429	420	404	388	441
Dove	330	309	275	251	237	306
Crow	201	194	188	184	184	127
Rainbowrose	501	507	498	469	448	588
Pyramids	285	281	266	258	248	222
Plates	323	300	280	267	255	329
Car	211	204	180	176	173	244
Trees	310	300	294	290	285	268
Ship	389	354	332	312	306	394
Waterfall	422	430	434	425	425	442
Total	7359	7163	6830	6522	6332	7181

4. PERFORMANCE EVALUATION USING LONGEST STRING AND LSRR PARAMETERS

Along with the conventional parameters precision and recall used for CBIR we have evaluated the system performance using two additional parameters namely Longest String and LSRR. As discussed in section 2.4, CBIR users will always have curiosity to check what will be the maximum continuous string of relevant images in the retrieval set which can be obtained using the parameter longest string. LSRR gives the performance of the system in terms of the maximum length of the sorted distances of all database images to be traversed to collect all relevant images of the query class.

4.1 Longest String

This parameter is plotted through various charts. As we have 12 different feature vector databases prepared for 4 moments for each of the three colors separately. We have calculated the longest string for all the 12 database results, but the plots for longest string are showing the maximum longest string obtained for each class for distances L1 to L6 irrespective of the three colors and this way we have obtained total 4 sets of results plotted in charts 2, 3, 4 and 5 for first four moments respectively. Among these few classes like Sunset, Rainbow rose, Barbie, Horses and Pyramids are giving very good results that more than 60 as maximum longest string of relevant images we could retrieve. In all the resultant bar of all graphs we can notice that L1 and L6 are reaching to good height of similarity retrieval.

TABLE 5 : PRCP FOR GREEN STANDARD DEV.

CLASS	L1	L2	L3	L4	L5	L6
Flower	320	352	332	319	296	376
Sunset	802	794	771	746	729	789
Mountain	243	249	236	225	223	238
Building	310	312	306	303	297	283
Bus	463	430	392	367	346	465
Diansour	359	358	347	338	328	304
Elephant	321	335	333	334	334	328
Barbie	461	416	401	395	385	430
Mickey	239	238	217	210	210	241
Horses	523	470	412	374	352	473
Kingfisher	368	389	363	353	348	383
Dove	355	307	270	243	238	315
Crow	238	211	192	192	187	120
Rainbowrose	647	652	624	590	577	708
Pyramids	351	350	334	323	319	174
Plates	345	345	330	317	311	370
Car	323	355	354	343	339	389
Trees	295	274	269	265	258	270
Ship	378	342	316	306	304	377
Waterfall	421	423	410	403	407	412
Total	7762	7602	7209	6946	6788	7445

TABLE 6 : PRCP FOR BLUE STANDARD DEV.

CLASS	L1	L2	L3	L4	L5	L6
Flower	315	324	319	318	315	325
Sunset	696	593	529	483	462	630
Mountain	210	204	217	212	212	209
Building	224	214	194	191	183	196
Bus	480	484	474	439	422	531
Diansour	318	298	278	273	271	261
Elephant	228	252	257	256	259	245
Barbie	454	363	319	284	264	381
Mickey	222	213	199	196	190	229
Horses	453	446	425	404	403	445
Kingfisher	322	336	333	321	318	333
Dove	352	334	300	280	262	338
Crow	208	165	160	158	152	109
Rainbowrose	615	619	599	587	558	687
Pyramids	242	238	232	228	226	196
Plates	263	261	255	251	246	290
Car	227	218	211	195	187	250
Trees	253	228	215	200	191	227
Ship	414	402	387	375	367	435
Waterfall	273	258	247	246	239	260
Total	6769	6450	6150	5897	5727	6577

4.2 LSRR

Similar to Longest String, the parameter LSRR is also used to evaluate the performance of 12 feature vector databases. As said earlier it gives the maximum length we need to travel in the string of distances sorted in ascending order to collect all images from database which are relevant to query image or say of query class. According to this logic of LSRR ; the value of LSRR should be as low as possible so that with minimum traversal length and with less time we can recall all the images from database. Results obtained for this parameter are the minimum values in terms of percentage of LSRR are calculated for all 12 feature vector databases for 200 query images with respect to all six similarity measures. The chart 6 is showing the results as best of LSRR that is minimum LSRR for each class of image for all distance measures L1 to L6 irrespective of three colors and four moments.

CHART 2: Max. In Results of Longest string of Mean parameter into 27 Bins

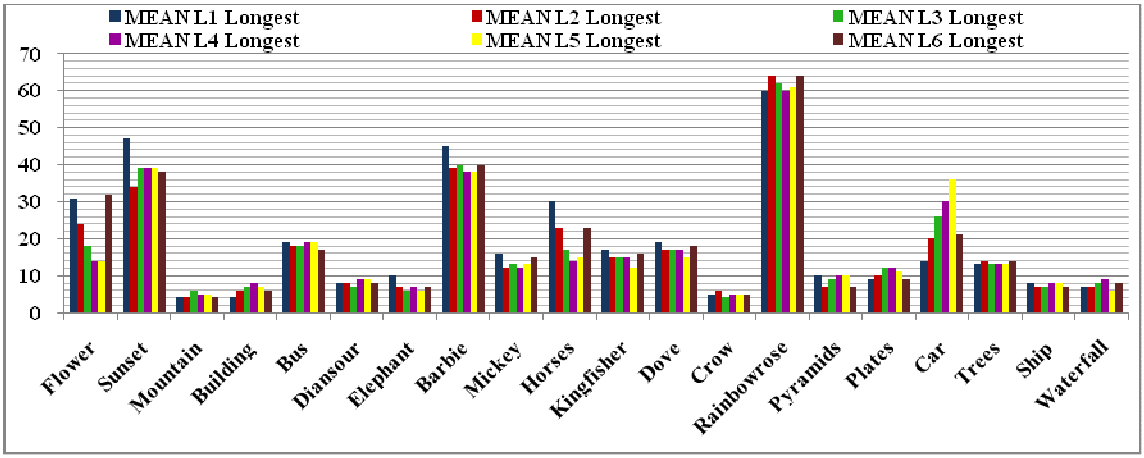


TABLE 7 : PRCP FOR RED SKEWNESS

CLASS	L1	L2	L3	L4	L5	L6
Flower	268	221	197	193	183	232
Sunset	646	578	524	495	482	635
Mountain	209	200	185	177	169	200
Building	223	211	199	182	176	214
Bus	422	411	391	380	369	429
Diansour	347	334	317	304	293	283
Elephant	246	271	280	281	277	237
Barbie	482	406	350	312	290	393
Mickey	245	249	241	237	226	229
Horses	399	389	350	313	303	391
Kingfisher	365	376	348	321	304	390
Dove	335	350	354	349	343	384
Crow	167	142	139	139	141	123
Rainbowrose	359	394	391	382	374	489
Pyramids	225	190	174	168	162	198
Plates	267	232	196	178	163	247
Car	155	161	157	152	148	225
Trees	296	279	260	248	247	225
Ship	342	297	268	256	249	311
Waterfall	362	352	332	319	309	263
Total	6360	6043	5653	5386	5208	6098

TABLE 8 : PRCP FOR GREEN SKEWNESS

CLASS	L1	L2	L3	L4	L5	L6
Flower	375	361	319	291	275	379
Sunset	674	617	563	530	506	679
Mountain	216	203	191	184	186	205
Building	252	224	214	207	212	203
Bus	441	418	378	349	342	451
Diansour	293	257	230	220	210	200
Elephant	222	227	219	210	206	204
Barbie	459	450	451	450	446	436
Mickey	234	237	226	213	208	233
Horses	383	335	294	271	248	380
Kingfisher	327	356	354	354	343	355
Dove	349	336	316	305	300	370
Crow	181	161	146	143	137	134
Rainbowrose	508	540	519	500	481	577
Pyramids	282	298	284	273	268	153
Plates	237	236	228	218	211	246
Car	276	363	374	377	367	404
Trees	216	180	173	174	170	192
Ship	316	281	267	257	249	292
Waterfall	321	292	267	250	248	279
Total	6562	6372	6013	5776	5613	6372

CHART 3: Max. In Results of Longest String of Standard Deviation parameter 27 Bins

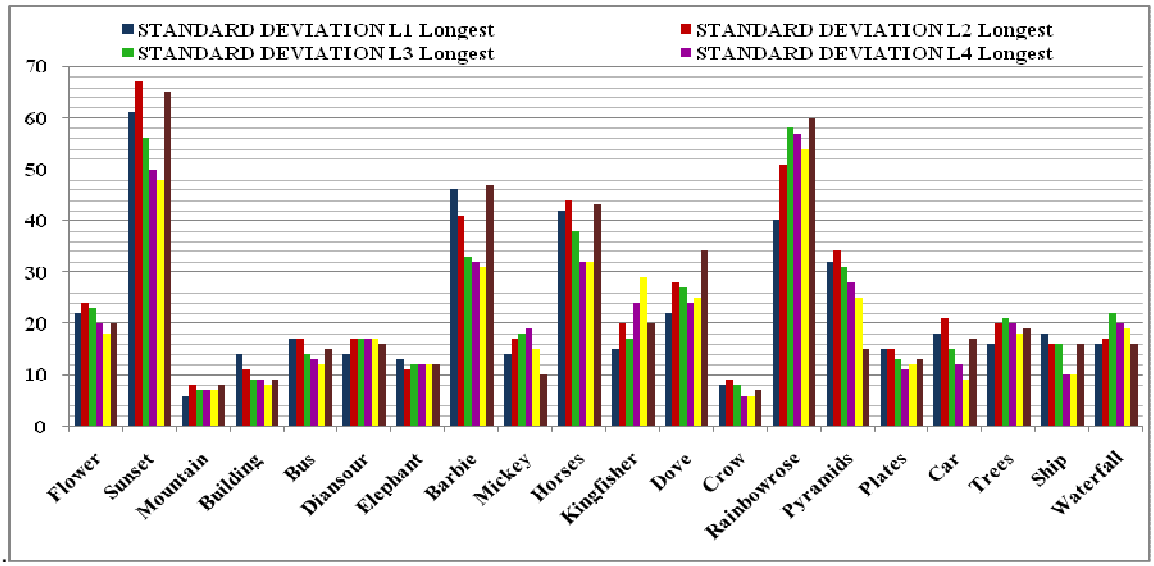


TABLE 9: PRCP FOR BLUE SKEWNESS

CLASS	L1	L2	L3	L4	L5	L6
Flower	335	331	322	314	302	342
Sunset	666	607	540	513	481	576
Mountain	205	208	201	195	191	209
Building	179	174	164	153	145	168
Bus	416	433	416	386	370	497
Diansour	290	247	231	226	222	244
Elephant	168	169	161	162	162	173
Barbie	458	419	387	372	341	413
Mickey	219	215	211	208	204	218
Horses	434	438	417	404	394	461
Kingfisher	247	262	258	255	250	253
Dove	385	346	333	317	314	399
Crow	177	162	147	153	149	118
Rainbowrose	490	514	519	517	497	575
Pyramids	204	195	184	174	169	194
Plates	249	241	230	218	210	262
Car	169	192	187	185	181	225
Trees	252	218	199	188	184	200
Ship	331	313	284	272	264	317
Waterfall	236	219	208	208	200	204
Total	6110	5903	5599	5420	5230	6048

TABLE 10: PRCP FOR RED KURTOSIS

CLASS	L1	L2	L3	L4	L5	L6
Flower	337	302	273	254	243	326
Sunset	340	695	655	624	610	734
Mountain	727	210	196	193	188	202
Building	217	240	226	220	218	257
Bus	274	493	485	468	459	500
Diansour	524	354	342	325	318	283
Elephant	349	343	355	361	367	333
Barbie	311	447	400	366	342	438
Mickey	488	255	240	236	227	250
Horses	260	486	461	432	416	511
Kingfisher	496	444	430	410	393	440
Dove	439	362	354	351	345	402
Crow	355	164	161	155	147	124
Rainbowrose	167	534	522	504	488	599
Pyramids	516	269	256	250	240	222
Plates	280	300	276	267	259	320
Car	315	190	179	176	174	242
Trees	206	287	282	269	269	260
Ship	309	363	334	322	316	389
Waterfall	405	434	436	430	422	420
Total	7315	7172	6863	6613	6441	7252

CHART 4: Max. In Results of Longest String of Skewness parameter 27 Bins

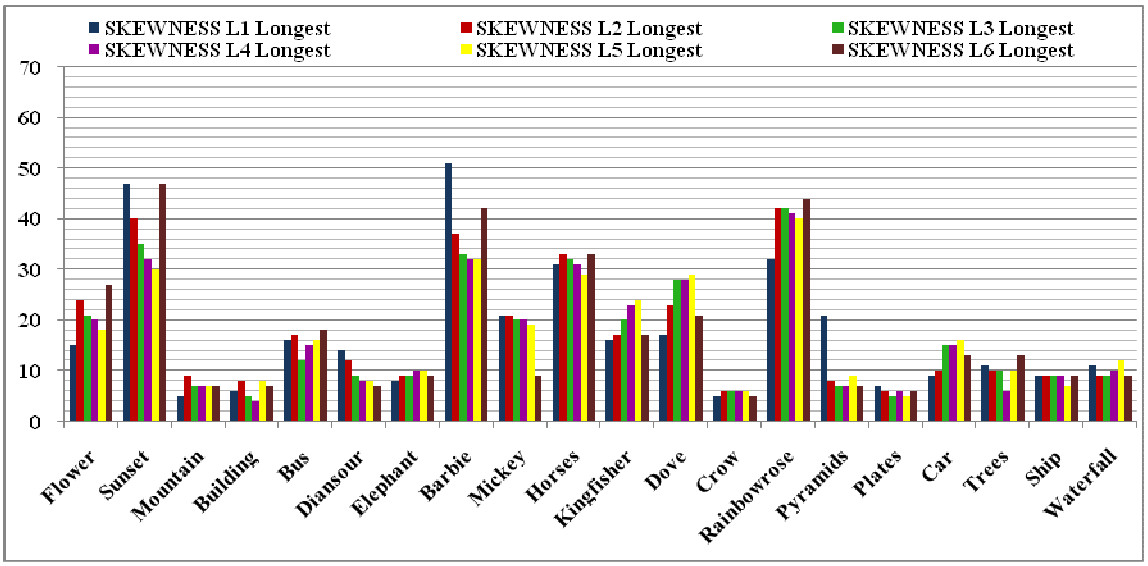


TABLE 11 : PRCP FOR GREEN KURTOSIS

	L1	L2	L3	L4	L5	L6
Flower	393	412	386	369	350	423
Sunset	801	788	761	735	717	803
Mountain	263	256	239	240	232	240
Building	316	295	289	281	267	274
Bus	533	478	428	411	384	503
Diansour	308	297	287	275	271	245
Elephant	321	323	329	328	329	313
Barbie	452	446	440	440	444	440
Mickey	254	246	241	220	210	238
Horses	512	441	377	343	326	454
Kingfisher	388	415	407	398	390	417
Dove	374	350	323	319	309	380
Crow	197	185	177	162	155	125
Rainbowrose	677	679	655	631	606	713
Pyramids	335	340	317	309	303	168
Plates	338	335	315	313	313	353
Car	327	363	357	358	356	398
Trees	279	249	245	240	231	251
Ship	395	344	320	306	302	368
Waterfall	413	406	390	385	382	397
Total	7876	7648	7283	7063	6877	7503

TABLE 12 : PRCP FOR BLUE KURTOSIS

	L1	L2	L3	L4	L5	L6
Flower	346	347	345	338	330	352
Sunset	760	688	604	566	541	674
Mountain	200	205	205	214	214	209
Building	214	208	196	189	177	205
Bus	487	493	459	436	420	530
Diansour	303	276	270	257	254	252
Elephant	211	224	231	230	230	234
Barbie	460	414	374	354	346	407
Mickey	231	222	218	213	212	231
Horses	469	454	449	434	422	459
Kingfisher	327	354	348	334	339	337
Dove	400	367	341	325	323	409
Crow	160	145	132	128	128	105
Rainbowrose	630	635	621	608	584	691
Pyramids	240	244	250	251	241	218
Plates	267	262	259	255	253	284
Car	214	211	197	187	183	235
Trees	246	216	196	185	179	204
Ship	407	393	380	370	360	408
Waterfall	276	249	243	244	245	253
Total	6848	6607	6318	6118	5981	6697

CHART 5 : Max. In Results of Longest String of Kurtosis Parameter _27 Bins

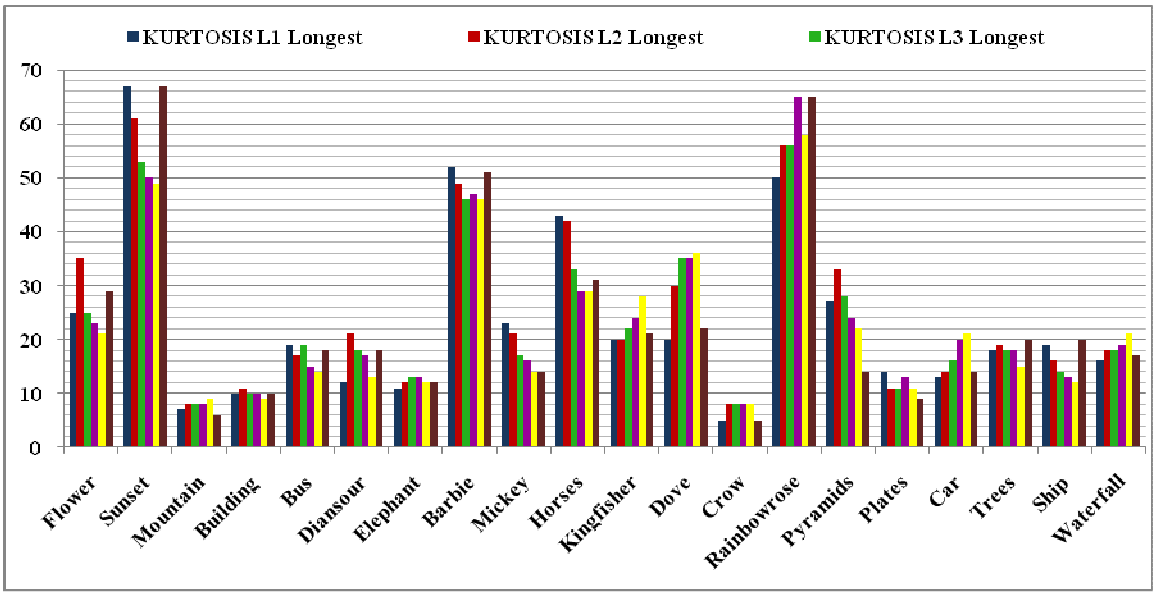
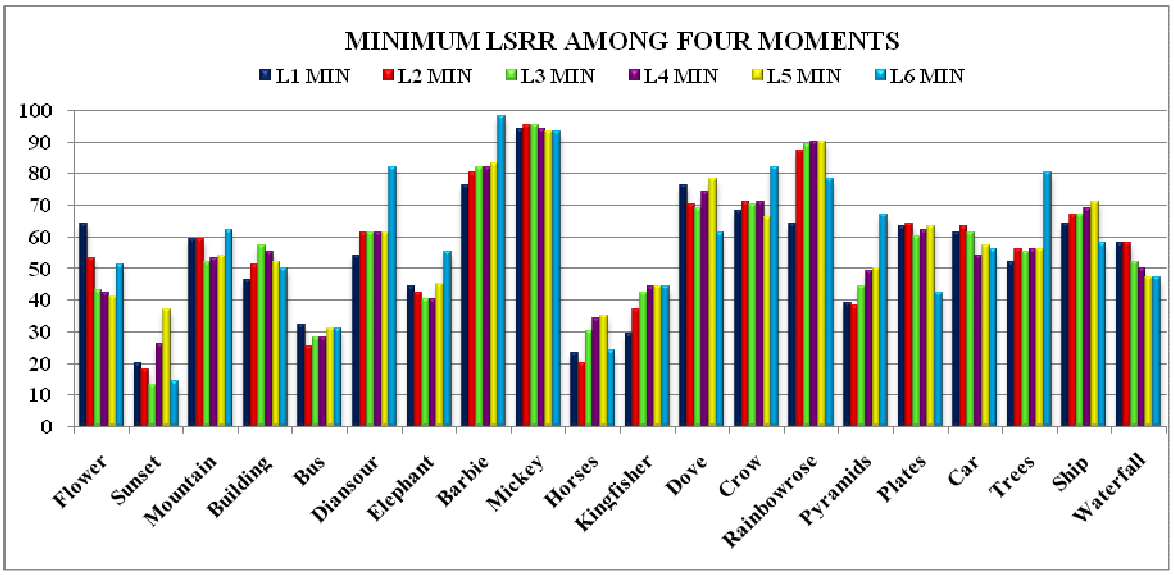


CHART 6. Min. In Results of LSRR for L1 to L6 Irrespective of Color and Moment



In above chart we can observe that many classes are performing well means minimum traversal is giving 100% recall for them the classes giving best results are sunset, bus, horses, kingfisher and pyramids etc. among these best is Sunset class where 14 %, traversal of 2000 images only will give 100 % recall for sunset query for L6, 20% for L1 distance measure.

We have shown first few images from the PRCP result obtained for Kingfisher query image in Figure 6. This is obtained for feature vector Green Kurtosis with the L1 distance measures. We retrieved total 65 images as PRCP(from first 100) for this query.

Query Image

Retreived Images…

FIGURE 6 : Query Image and first 46 images retreived out of 65

CONCLUSION

The 'Bins Approach' explained in this paper is new and simple in terms of computational complexity for feature extraction. It is based on histogram partitioning of three color planes. As histogram is partitioned into 3 parts, we could form 27 bins out of it. These bins are directed to extract the features of images in the form of four statistical moments namely Mean, Standard Deviation, Skewness and Kurtosis.

Similarity measures used to facilitate the comparison of database and query images we have used two similarity measures that are Minkowski distance and Cosine correlation distance. We have used multiple variations of Minkowski distance from order 1 to order 5 with nomenclature L1

to L5 and L6 is used for cosine correlation distance. Among these six distances L1 and L6 are giving best performance as compared to other increasing orders of Minkowski distance. Here we have seen that performance goes on decreasing with increase in Minkowski order parameter 'r' given in equation 5.

Conventional CBIR systems are mostly designed with Euclidean distance. We have shown the effective use of other two similarity measures 'Absolute distance' and 'Cosine correlation distance'. The work presented in this paper has proved that AD and CD are giving far better performance as compared to the commonly adopted conventional similarity measure Euclidean distance. In all tables having PRCP results we have highlighted first two best results and after counting them and comparing we found that AD and CD are better in maximum cases as compared to ED.

Comparative study of types of feature vectors based on moments, even moments are performing better as compared to odd moments i.e. standard deviation and kurtosis are better than mean and skewness.

Observation of all performance evaluation parameters delineates that the best value obtained for PRCP is 0.8 for average of 10 queries for many out of the 20 classes. Whereas combining the R, G, B color results using special criterion; the best value of PRCP works out to 0.5 for average of 200 queries which is the most desirable performance for any CBIR. The maximum longest string of relevant images obtained is for class rainbow rose and sunset; the value is around 70 (out of 100) for L1 and L6 distance measure as shown in charts 3 and 5 for even moments. The minimum length traversed to retrieve all the relevant images from database i.e LSRR's best value is 14% for L6 and 20% for L1 for class sunset.

We have also worked with 8 bins and 64 bins by dividing the equalized histogram in 2 and 4 parts respectively. However the best results are obtained for 27 bins which are presented here.

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