IMAGE RETRIEVAL USING TEXTURE FEATURES EXTRACTED USING LBG, KPE, KFCG, KMCG, KEVR WITH ASSORTED COLOR SPACES

H.B.Kekre[1], Sudeep D. Thepade[2], Tanuja K. Sarode[3], Shrikant P. Sanas[4]
[1]Sr. Professor, [2] Associate Professor, [3]Associate Professor, [4] Lecturer ,
MPSTME, SVKM's NMIMS University, Vile Parle (W), Mumbai, India
[3]Thadomal Shahani Engg. College, Mumbai, India, [4]Lecturer, RAIT, Mumbai, India

ABSTRACT

This paper presents novel texture based content based image retrieval(CBIR) methods using six assorted color spaces i.e RGB, LUV, YCgCb, YIQ, YCbCr, YUV. For extracting texture feature Vector Quantization (VQ) algorithms like Linde Buzo Gray(LBG), Kekre's Proportionate Error (KPE), Kekre's Error Vector Rotation (KEVR), Kekre's Median Codebook Generation (KMCG) and Kekre's Fast Codebook Generation (KFCG) algorithms are used. The codebook generated from these algorithms act as the feature vector for CBIR system. Seven different codebook sizes varying from 8x12 to 512x12 are generated in six color spaces and using five different VQ algorithms, so in all 210 (7x6x5) techniques are presented here. The proposed image retrieval techniques are tested on generic image database having 1000 images and is independent of the image size and rotation invariant. To test the performance of the proposed CBIR techniques Precision and Recall is used. From the results it is observed that KFCG gives best results with higher precision and recall values. Codebook size 128x12 gives best result in all codebook generation algorithms.

KEYWORDS: *CBIR, Vector Quantization, LBG, KPE, KFCG,KEVR,KMCG*

I. INTRODUCTION

Visual communication plays an important role in modern communication system. We live in the digital era where the advancement in information and communication technology takes place every day. Large amount of digital data is generated, transmitted, stored, analyzed and accessed. Mostly information is in the form of multimedia nature such as digital images, audio, video and graphics. From various sources large amount of images are generated and it takes large volume to store. This stored information is in the form of images. It is more complex to retrieve and difficult to store in large volume. The need for efficient retrieval of images has been recognized by managers of large image collections. To develop efficient indexing techniques for the retrieval of enormous volumes of images being generated these days, we need to achieve reasonable solutions to these above mentioned problems needs to be achieved. Content based image retrieval gives solution of above problem.

The term 'content' in CBIR refers to colors, shapes, textures, or any other information that can be possibly obtained from the image itself and 'Content Based' denotes that the search will consider the concrete contents of the image. It gives query as Image and output is number of matching images to query image. In a CBIR, features are used to represent the image content. The features are extracted automatically and there is no manual intervention, thus eliminating the dependency on humans in the feature extraction stage. The typical CBIR system performs two major tasks. The first one is feature extraction (FE), where a set of features, called feature vector, is generated to accurately represent the content of each image in the database. A feature vector is much smaller in size than the original image. The second task is similarity measurement (SM), where a distance between the query image and each image in the database using their signatures is computed so that the top "closest" images can be retrieved. Many current CBIR system use Euclidean distance on the extracted feature set as a similarity measure. The Direct Euclidian distance between image P and query image Q is given in equation 1. where Vpi and Vqi are the feature vectors of image P and query image Q respectively with size 'n'.

$$ED = \frac{1}{2}\sqrt{\sum_{i=1}^{n}\left(Vpi - Vqi\right)^{2}} \qquad (1)$$

A variety of feature extraction techniques have been developed. Color based feature extraction techniques include color histogram, color coherence vector, color moments,, circular ring histogram [4,16], BTC extensions [17,18,20]. Texture based feature extraction techniques such as co-occurance matrix [6], Fractals [2], Gabor filters [2], variations of wavelet transform [1], Kekre transform [7,9,12] have been widely used. Effort has been made in even to extend image retrieval methodologies using combination of color and texture as the case in [8] where Walshlet Pyramids are introduced. The synergy resulting from the combination of color and texture is demonstrated to be superior than using just color and texture [13, 14, 15].

II. TEXTURE FEATURE EXTRACTION METHODS

Texture is important component of human visual perception and can be effectively used for identifying different image regions [1]. Compared with color and shape features, texture features[5] indicate the shape distribution, better suits the macrostructure and microstructure of the images [2]. Texture representation methods can be classified into three categories, namely structural, statistical and multi-resolution filtering methods. The identification of specific textures in an image is achieved primarily by modeling texture as a two-dimensional gray level variation [6, 13]. This two dimensional array is called as Gray level Co-occurrence Matrix (GLCM). GLCM describes the frequency of one gray tone appearing in a specified spatial linear relationship with another gray tone, within the area under investigation.

III. VECTOR QUANTIZATION

Vector Quantization is an efficient technique for data compression [10]. VQ has been very popular in variety of research fields such as video-based event detection, speech data compression, image segmentation, CBIR, face recognition, iris recognition, data hiding etc. VQ can be defined as the mapping function that maps k-dimensional vector space to the finite set CB = { C1, C2, C3, . .., CN}. The set CB is called codebook consisting of N number of code vectors and each code vector Ci = {ci1, ci2, ci3, ……, cik} is of dimension k. The codebook is the feature vector of the entire image and can be generated by using clustering techniques. Here we calculate results on different size of Codebooks like 8, 16, 32, 64, 128, 256 and 512 are used.
Five assorted algorithms are used in Vector Quantization to generate codebooks alias Linde-Buzo-Gray Algorithm(LBG)[3], Kekre's Proportionate Error Algorithm (KPE)[17], Kekre's Error Vector Rotation Algorithm(KEVR)[23], Kekre's Fast CodeBook Genearion Algorithm(KFCG)[11][19][21], and Kekre's Median CodeBook Genaration Algorithm (KMCG)[24].

IV. COLOR SPACES

Many attempts have been made to model color perception by researchers of various fields: psychology, perception, computer vision, image retrieval, and graphics. Some of these resulted in well defined color spaces. The list of color spaces is almost endless. A few of the most important color spaces are: RGB (Red, Green, and Blue), HSV (Hue, Saturation, and Value), HIS (also named HSB), rgb, XYZ, Kekre's YCgCb, Kekre's LUV, YUV, YIQ, YCbCr. Color spaces are needed in the representation of color-ranges. The manipulation of colors, as is done in the graphics industry. Mixing of colors. The retrieval (i.e. matching) of colors. So it is evident that CBIR engines [22], using color as feature, need a color space for color matching. However, often CBIR engines also use a color space in their color selection interface.

V. RESULTS AND DISCUSSIONS

The CBIR techniques are tested on the augmented Wang image database of 1000 variable size images spread across 11 categories of human beings, animals, natural scenery and man-made things. Image database contains various size of images. Figure 1 shows the sample database of 16 images randomly selected from each category. The images are of varying sizes ranging from 384x256 to 84x128. From each category randomly selected 5 images are treated as queries which are fired for obtaining the results of proposed CBIR methods.

Figure 1: Sample Image from the considered Image Database

The performance of proposed CBIR methods is evaluated using the crossover point value of average precision and average recall values for considered queries. The standard definitions of precision and recall are given by equation 2 and equation 3. Precision gives the accuracy where as the Recall gives completeness.

$$\text{Precesion} = \frac{\text{Number\_of\_relevant\_images\_retrieved}}{\text{Total\_number\_of\_images\_retrieved}} \quad (2)$$

$$\text{Recall} = \frac{\text{Number\_of\_relevant\_images\_retrieved}}{\text{Total\_number\_of\_relevent\_images\_in\_database}} \quad (3)$$

Figure 2 shows the crossover point, the point where precision and recall crosses. This crossover point is used as the performance measure of CBIR techniques. Higher value of the crossover point of precision and recall reflects better performance.

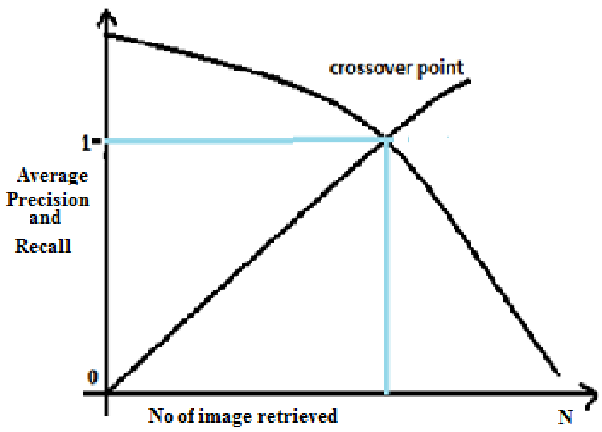

Figure 2. Crossover point of average precision and recall.

Figure 3 gives crossover points of average precision and average recall values of the LBG based CBIR techniques for all considered codebook sizes and different color spaces tested on Wang image database. Here the codebook sizes 16, 32 and 64 are better with higher crossover point values in all color spaces except the RGB color space. The precision and recall crossover point of codebook size 32 for LUV color space is higher than the same for other codebook sizes and color spaces indicating better performance for LBG-CBIR on Wang image database.

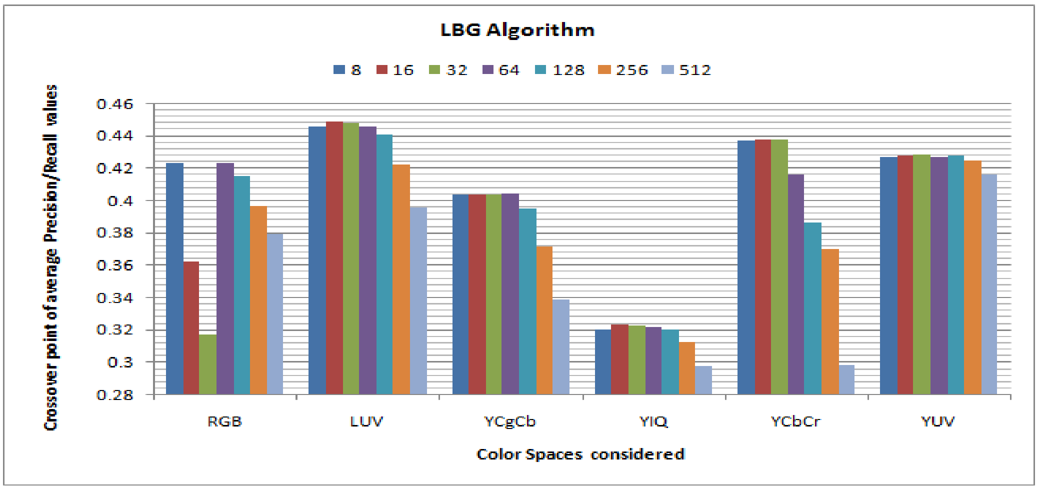

Figure 3: Performance comparison of various color spaces of different Codebook sizes for LBG algorithm using Precision-Recall crossover points.

Figure 4 gives crossover points of average precision and average recall values of the KPE based CBIR techniques for all codebook sizes and different color spaces tested on Wang image database. Here the codebook sizes 8 and 16 are better with higher crossover point values in all color spaces. The precision and recall crossover value of codebook size 8 for YCbCr color space is higher than the same for other codebook sizes and color spaces indicating better performance for KPE-CBIR on Wang image database.

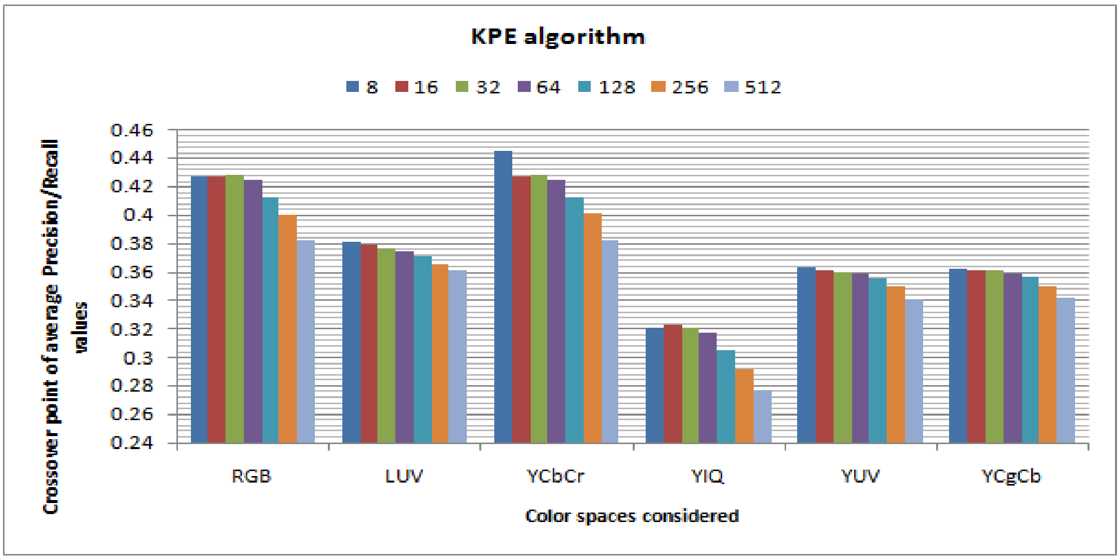

Figure 4 : Performance comparison of various color spaces of different Codebook sizes for KPE algorithm using Precision-Recall crossover points

Figure 5 gives crossover points of average precision and average recall values of the KEVR based CBIR techniques for all codebook sizes and different color spaces tested on Wang image database. Here the codebook sizes 64 and 128 are better with higher crossover point values. The precision and recall crossover point value of codebook size 128 for YCbCr color space is higher than the same for other codebook sizes and color spaces indicating better performance for KEVR-CBIR on Wang image database.

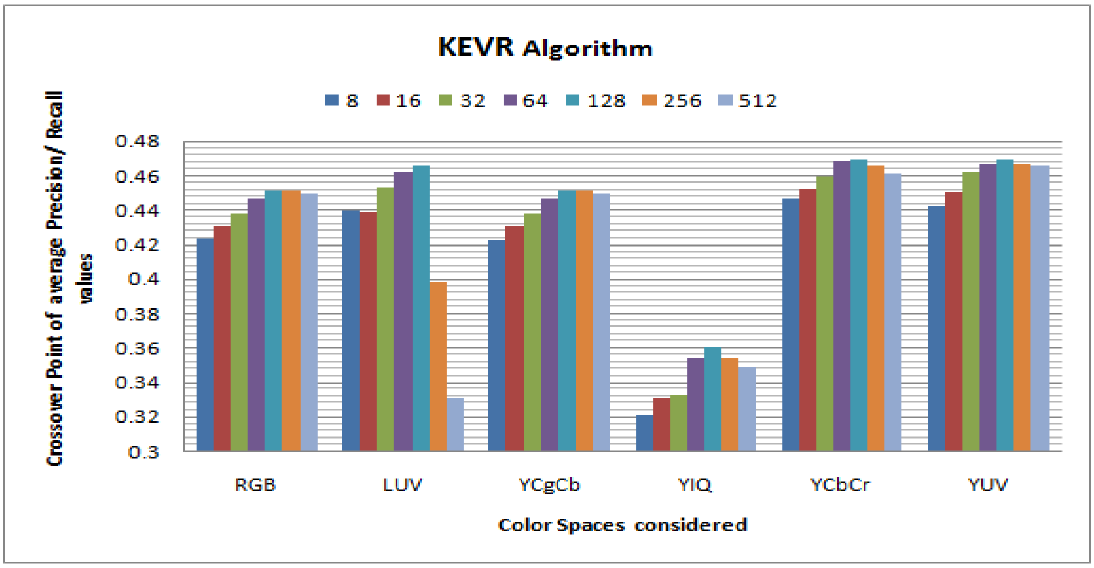

Figure 5 : Performance comparison of various color spaces of different Codebook sizes for KEVR algorithm using Precision-Recall crossover points

Figure 6 gives crossover points of average precision and average recall values of the KFCG based CBIR techniques for all codebook sizes and different color spaces tested on Wang image database. Here the codebook sizes 128 and 256 are better with highest crossover point value. The precision and recall curves of codebook size 256 for RGB color space are higher than other codebook sizes and color spaces indicating better performance for KFCG-CBIR on Wang image database.

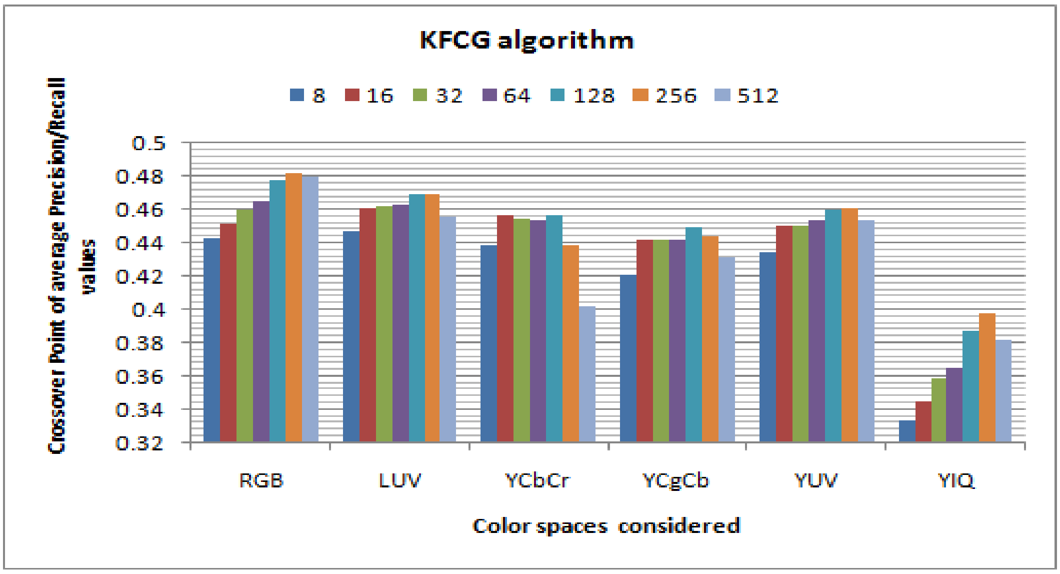

Figure 6 : Performance comparison of various color spaces of different Codebook sizes for KFCG algorithm using Precision-Recall crossover points

Figure 7 gives crossover points of average precision and average recall values of the KMCG based CBIR techniques for all codebook sizes and different color spaces tested on Wang image database. Here the codebook sizes 128 and 256 are better with highest crossover point value. The precision and recall curves of codebook size 128 for LUV color space are higher than other codebook sizes and color spaces indicating better performance for KMCG-CBIR on Wang image database.

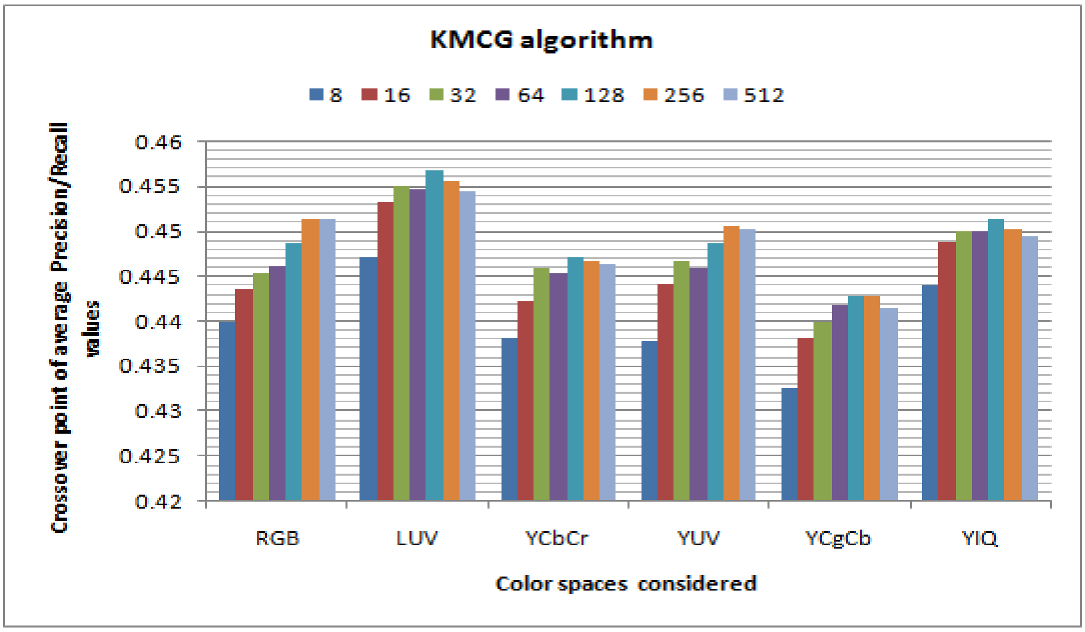

Figure 7: Performance comparison of various color spaces of different Codebook sizes for KMCG algorithm using Precision-Recall crossover points

5.1: Results according to Different Color Spaces.

Her proposed CBIR methods with respect to various color spaces are discussed for respective codebook generation techniques.

Figure 8 shows the comparison between various sizes of codebook for RGB color spaces. Codebook size 128 and 256 gives the better result than other size of codebook. After codebook size 256 graphs is slightly decreasing because more no of voids are created. KFCG gives the better result as compared to other VQ methods.

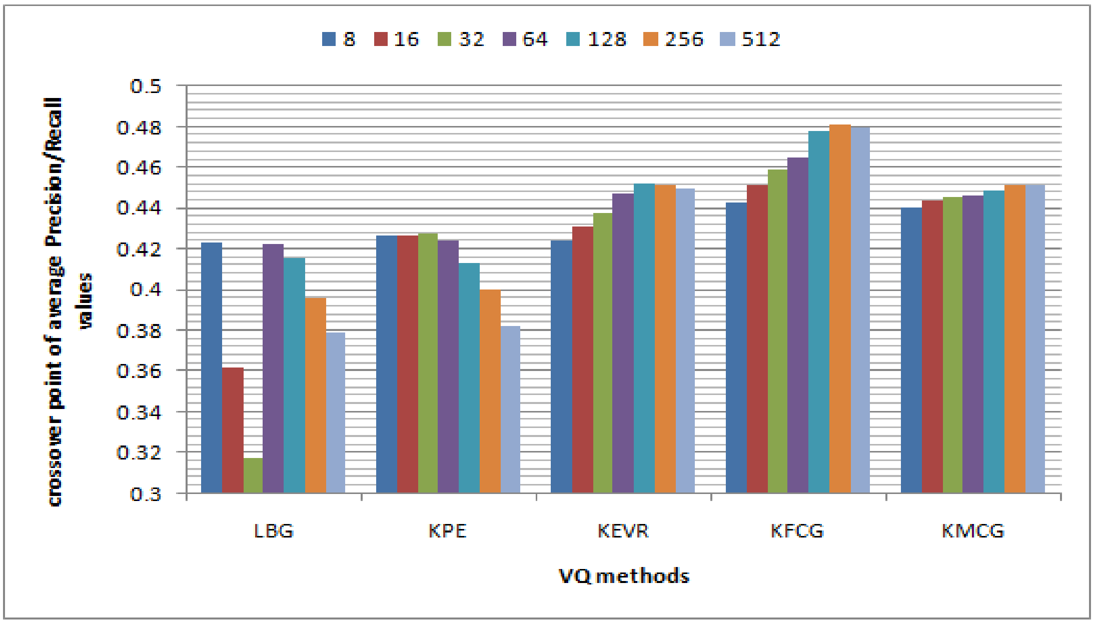

Figure 8 : Crossover points of Avg Precision & Recall plotted against the various VQ methods for RGB color space.

Figure 9 shows the comparison between various sizes of codebook for LUV color spaces. Codebook size 128 gives the better result than other size of codebook. KFCG gives the better result as compared to other VQ methods.

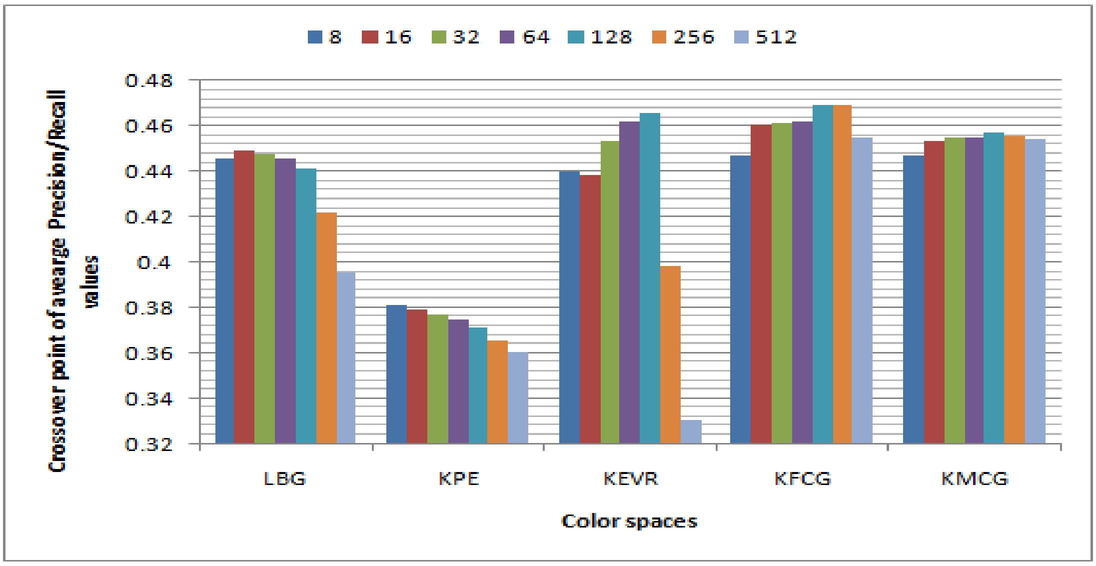

Figure 9 : Crossover points of Avg Precision & Recall plotted against the various VQ methods for LUV color space.

Figure 10 shows the comparison between various sizes of codebook for YUV color spaces. Codebook size 128 and 256 gives the better result than other size of codebook. KEVR gives the better result as compared to other VQ methods.

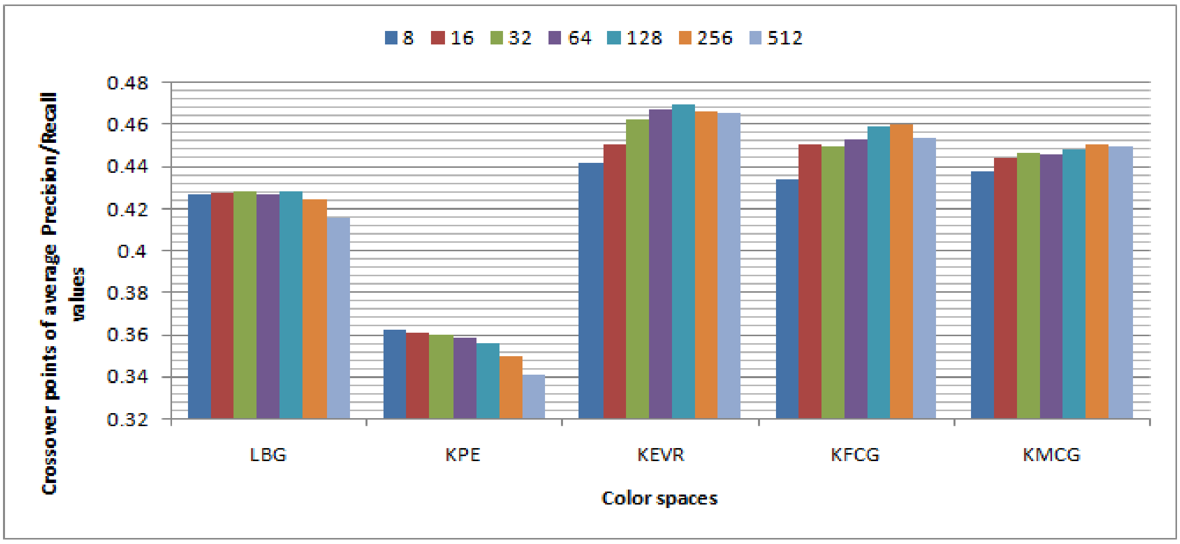

Figure 10: Crossover points of Avg Precision & Recall plotted against the various VQ methods for YUV color space.

Figure 11 shows the comparison between various sizes of codebook for YCbCr color spaces. Codebook size 64 and 128 gives the better result than other size of codebook. KEVR gives the better result as compared to other VQ methods.

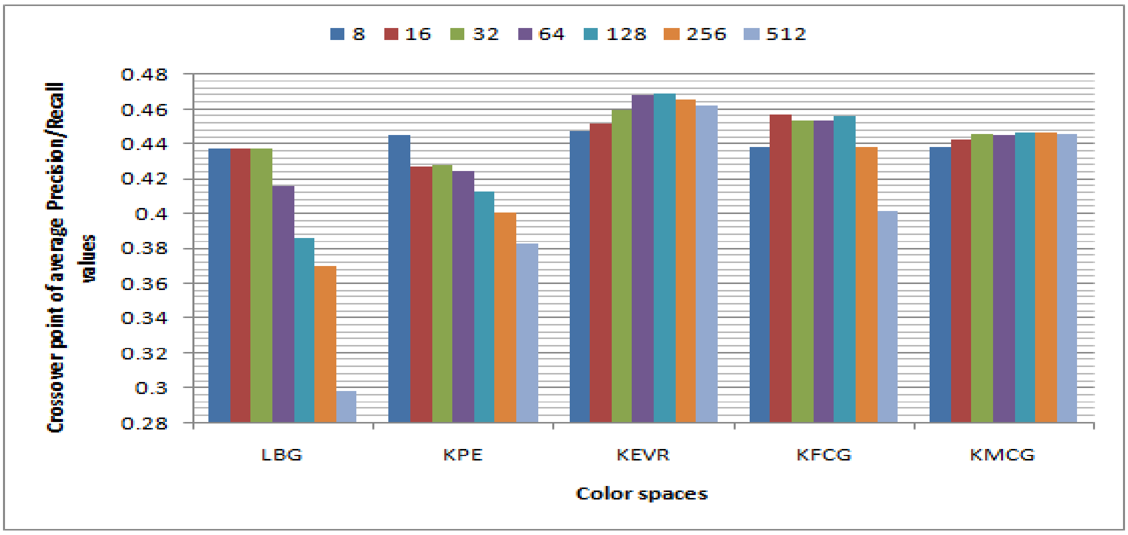

Figure 11: Crossover points of Avg Precision & Recall plotted against the various VQ methods for YCbCr color space**.**

Figure 12 shows the comparison between various sizes of codebook for YCgCb color spaces. Codebook size 128 and 256 gives the better result than other size of codebook. KEVR gives the better result as compared to other VQ methods.

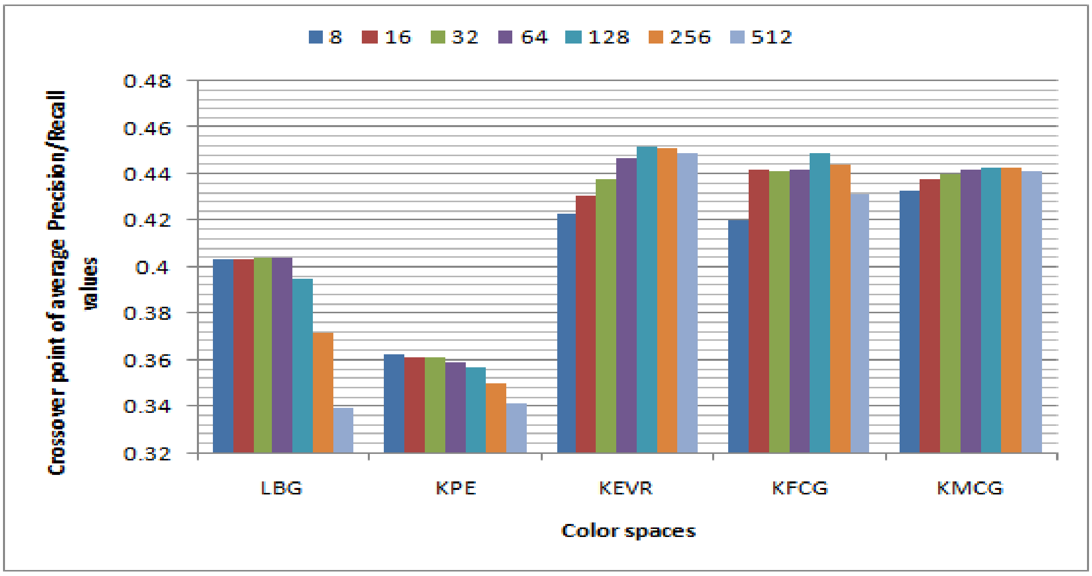

Figure 12: Crossover points of Avg Precision & Recall plotted against the various VQ methods for YCgCb color space.

Figure 13 shows the comparison between various sizes of codebook for YIQ color spaces. Codebook size 128 gives the better result than other size of codebook. KMCG gives the better result as compared to other VQ methods.

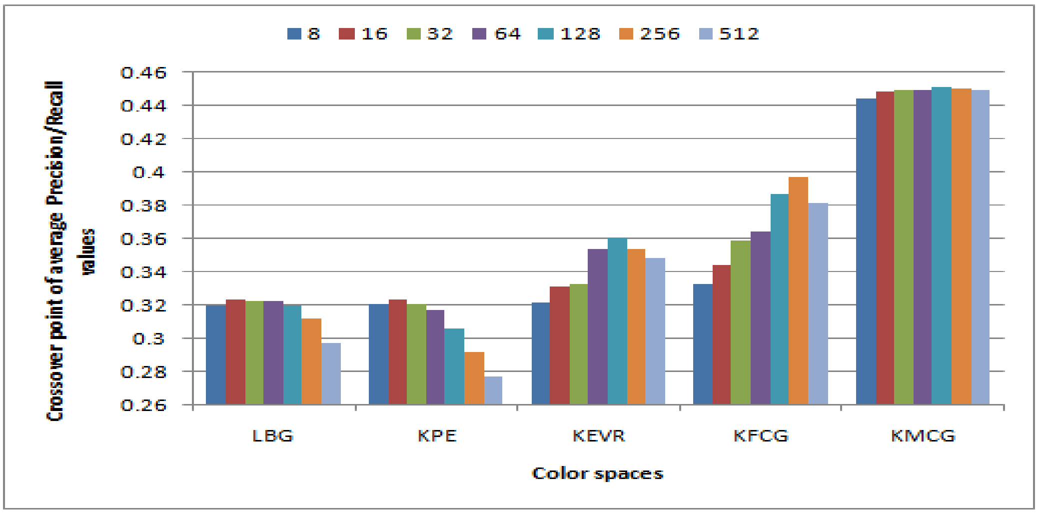

Figure 13: Crossover points of Avg Precision & Recall plotted against the various VQ methods for YIQ color space.

5.2. Disscussion.

Table 1 shows the best Crossover values for respective color spaces and codebook sizes with respect to VQ algorithms LBG, KEVR, KPE, KFCG, KMCG. It is observed that LBG algorithm in Kekre's LUV space gives higher crossover point for codebook size 16. In LBG-CBIR YUV color space gives better result in all size of codebook. YIQ gives worst result compare to other color spaces. KPE algorithm in YCbCr color space gives better result for codebook size 8. In KPE-CBIR YCbCr color space gives average result and YIQ color space gives worst result as compare to other color spaces. KEVR algorithm in YUV color space gives better results for codebook size 128. In KEVR-CBIR LUV and YCbCr color space gives average result and YIQ color space gives worst result as compare to other color spaces. KMCG algorithm in LUV color space gives better result for codebook size128. In KFCG algorithm RGB color space gives better result for codebook size 256 where as LUV color space gives average result while YIQ and YUV color space gives worst results.

Table 1. Best Crossover values for respective color space and codebook size with respect to various VQ algorithms.

Algorithm	Color space	codebook size	crossover point
LBG	LUV	16	0.44885
KEVR	YUV	128	0.469673
KPE	YCbCr	8	0.4445
KMCG	LUV	128	0.45675
KFCG	**RGB**	**256**	**0.4815**

Table 2 shows the best Crossover values for various algorithms and codebook sizes with respect to various color spaces. It is observed from the table that KFCG algorithm gives highest crossover point in RGB color space for codebook size 256. KEVR and KMCG gives average result where as LBG gives worst results in RGB color space as compare to other algorithms. LUV color space gives better results for codebook size 128 of KFCG. KMCG and KEVR algorithm gives average result and KPE algorithm gives worst results in LUV space. In YUV color space KEVR algorithm gives higher crossover point for codebook size 128 where as KFCG and KMCG gives average results and KPE algorithm gives worst result. KEVR algorithm gives better result for codebook size 128 in YCbCr color space where as KFCG and KMCG algorithm give average result while LBG algorithm gives worst result as compare to others algorithm. In YCgCb color space KEVR algorithm gives better result for codebook size 128. KFCG and KMCG algorithm give average result while KPE algorithm gives worst result in YCgCb color space. KMCG algorithm gives better result for codebook size 128 in YIQ color space while KFCG gives average result where as KPE gives worst result. As compare to all the results RGB color space Kerkre's fast codebook generation algorithm gives best performance crossover value is 0.4814 for codebook size 256.

Table 2 : Best Crossover values for various algorithms and codebook sizes with respect to various color spaces.

Color space	Algorithm	codebook size	crossover point
RGB	KFCG	256	0.4815
LUV	KFCG	128	0.46905
YUV	KEVR	128	0.46967
YCbCr	KEVR	128	0.46916
YCgCb	KEVR	128	0.4517
YIQ	KMCG	128	0.45125

VI. CONCLUSION

The performance of CBIR system depends on the precision and recall. The crossover point of precision and recall is taken as criteria for judging the performance of CBIR technique. The use of vector quantization codebooks as feature vectors for image retrieval is proposed in the paper. The codebook generation techniques such as of Linde-Buzo-Gray (LBG), Kekre's Proportionate Error Algorithm(KPE), Kekre's Fast Codebook Generation algorithm, Kekre's Median Codebook Generation algorithm and newly introduced Kekre's Error Vector Rotation (KEVR) algorithms for texture feature extraction are used. These codebooks extracted with sizes 8, 16, 32, 64, 128, 256 and 512 are used in proposed CBIR techniques. Six different color spaces are used. Thus the five codebook generation algorithms, seven different codebook sizes and six color spaces per algorithm results into 210 variations of proposed image retrieval techniques. All these variations are tested on Wang image database of 1000 images. As compared to all the discussed CBIR variations results Kerkre's fast codebook generation algorithm in RGB color space gives best performance crossover value is 0.4814 for codebook size 256.

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Author Biographies

H. B. Kekre has received B.E. (Hons.) in Telecomm. Engineering. from Jabalpur University in 1958, M.Tech (Industrial Electronics) from IIT Bombay in 1960, M.S.Engg. (Electrical Engg.) from University of Ottawa in 1965 and Ph.D. (System Identification) from IIT Bombay in 1970 He has worked as Faculty of Electrical Engg. and then HOD Computer Science and Engg. at IIT Bombay. For 13 years he was working as a professor and head in the Department of Computer Engg. at Thadomal Shahani Engineering. College, Mumbai. Now he is Senior Professor at MPSTME, SVKM's NMIMS. He has guided 17 Ph.Ds, more than 100 M.E./M.Tech and several B.E./ B.Tech projects. His areas of interest are Digital Signal processing, Image Processing and Computer Networking. He has more than 270 papers in National / International Conferences and Journals to his credit. He was Senior Member of IEEE. Presently He is Fellow of IETE and

Life Member of ISTE Recently seven students working under his guidance have received best paper awards. Currently 10 research scholars are pursuing Ph.D. program under his guidance.

Sudeep D. Thepade has Received B.E.(Computer) degree from North Maharashtra University with Distinction in 2003. M.E. in Computer Engineering from University of Mumbai in 2008 with Distinction, Ph.D. from SVKM's NMIMS in 2011, Mumbai. He has about 09 years of experience in teaching and industry. He was Lecturer in Dept. of Information Technology at Thadomal Shahani Engineering College, Bandra(w), Mumbai for nearly 04 years. Currently working as Associate Professor and HoD Computer Engineering at Mukesh Patel School of Technology Management and Engineering, SVKM's NMIMS, Vile Parle(w), Mumbai, INDIA. He is member of International Advisory Committee for many International Conferences, acting as reviewer for many referred international journals/transactions including IEEE and IET. His areas of interest are Image Processing and Biometric Identification. He has guided five M.Tech. projects and several B.Tech projects. He more than 125 papers in National/International Conferences/Journals to his credit with a Best Paper Award at International Conference SSPCCIN-2008, Second Best Paper Award at ThinkQuest-2009, Second Best Research Project Award at Manshodhan 2010, Best Paper Award for paper published in June 2011 issue of International Journal IJCSIS (USA), Editor's Choice Awards for papers published in International Journal IJCA (USA) in 2010 and 2011..

Tanuja K. Sarode has Received Bsc.(Mathematics) from Mumbai University in 1996, Bsc.Tech.(Computer Technology) from Mumbai University in 1999, M.E. (Computer Engineering) degree from Mumbai University in 2004, Ph.D. from Mukesh Patel School of Technology, Management and Engineering, SVKM's NMIMS University, Vile-Parle (W), Mumbai, INDIA. She has more than 11 years of experience in teaching. Currently working as Assistant Professor in Dept. of Computer Engineering at Thadomal Shahani Engineering College, Mumbai. She is life member of IETE, member of International Association of Engineers (IAENG) and International Association of Computer Science and Information Technology (IACSIT), Singapore. Her areas of interest are Image Processing, Signal Processing and Computer Graphics. She has more than 100 papers in National /International Conferences/journal to her credit.

Shrikant Sanas has received B.E. (Computer) degree from Mumbai University with First Class in 2008. M.-Tech. in Computer Engineering from Mukesh Patel School of Tech. Mgmt. and Engineering. SVKM's NMIMS University Mumbai. in 2011 with Distinction. Currently working as Lecturer in Ramrao Adik Institute of Technology. Nerul, Navi Mumbai. His areas of interest are Image Processing and Database. He has 05 papers in International Journals.