Boosting Block Truncation Coding with Kekre's LUV Color Space for Image Retrieval

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***Abstract*—**The rapid growth of World Wide Web (WWW) and Information and Communication Technology (ICT), have increased the interest of people in the potential of images to store and share the information. The number of image achieves are growing with the jet speed. Just having the tremendous amount of information is not useful unless we don't have the methodologies to effectively search the related data from it in minimum possible duration. The relativity of the image data is application specific. The need to find a desired image from a collection is shared by many professional groups, including journalists, design engineers and art historians.

Current indexing practice for images relies largely on text descriptors or classification codes, supported in some cases by text retrieval packages designed or adapted specially to handle images. Here to search and retrieve the expected images from the database we need Content Based Image Retrieval (CBIR) system. CBIR operates on a totally different principle from keyword indexing. Primitive features characterizing image content, such as color, texture, and shape are computed for both stored and query images, and used to identify the images most closely matching the query. There have been many approaches to decide and extract the features of images in the database.

Block Truncation Coding (BTC) based feature is one of the CBIR methods proposed using color features of image. The approach basically considers red, green and blue planes of image together to compute feature vector. Here we have boosted this BTC based CBIR as BTC-LUV and Spatial BTC-LUV. Here Kekre's LUV color space is considered. In BTC-LUV feature vector is computed by considering L, U and V planes of the image independently. While in Spatial BTC-LUV, the feature vector is composed of four parts. Each part is representing the features extracted from one of the four non overlapping quadrants of the image. The new proposed methods are tested on the database of 1000 images and the results show that the precision is improved in Spatial BTC-LUV and recall is better in BTC-LUV. If both precision and recall are considered together Spatial BTC-LUV outperforms the other methods discussed in the paper.

***Keywords*—**CBIR, BTC, RGB Color Space, Kekre's LUV Color Space, Spatial BTC.

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I. Introduction

FROM ages images have been the mode of communication for human being. Today we are able to generate, store, transmit and share enormous amount of data because of the exhaustive growth of Information and Communication Technology. Much of this information is multimedia in nature, which consists of digital images, video, audio, graphics, and text data [10],[16]. But all that information is only useful if one can access it efficiently. This does not only mean fast access from a storage management point of view but also means that one should be able to find the desired information without scanning all information manually.

Users in many professional fields are exploiting the opportunities offered by the ability to access and manipulate remotely-stored images in all kinds of new and exciting ways [39],[40]. However, they are also discovering that the process of locating a desired image in a large and varied collection can be a source of considerable frustration [41],[42]. The problems of image retrieval are becoming widely recognized, and the search for solutions is an increasingly active area for research and development.

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. Some kinds of solutions have been achieved with apparently promising experimental results.

Problems with traditional methods of image indexing [46] have led to the rise of interest in techniques for retrieving images on the basis of automatically-derived features such as color, texture and shape – a technology now generally referred to as *Content-Based Image Retrieval* (CBIR). After a decade of intensive research, CBIR technology is now beginning to move out of the laboratory and into the marketplace, in the form of commercial products like QBIC [45] and Virage [44]. However, the technology still lacks maturity, and is not yet being used on a significant scale. In the absence of hard evidence on the effectiveness of CBIR techniques in practice, opinion is still sharply divided about their usefulness in handling real-life queries in large and diverse image collections.

The goal of an image retrieval system is to retrieve a set of images from a collection of images such that this set meets the user's requirements. The user's requirements can be specified in terms of similarity to some other image or a sketch, or in terms of keywords. An image retrieval system provides the user with a way to access, browse and retrieve efficiently and possibly in real time, form these databases [7]. Well-developed and popular international standards, on image coding have also long been available and widely used in many applications.

The challenge to image indexing is studied in the context of image database, which has also been actively researched by researchers from a wide range of disciplines including those from computer vision, image processing, and traditional database areas for over a decade. Image retrieval systems can be divided into two main types: Text Based Image Retrieval and Content Based Image Retrieval. In the early years Text Based Image Retrieval was popular, but nowadays Content Based Image Retrieval has been a topic of intensive research [10].

A. *Text Based Image Retrieval*

Text Based Image Retrieval is the traditional image retrieval system. In traditional retrieval systems features are added by adding text strings describing the content of an image. In contrast to text, images just consist of pure pixel data with no inherent meaning. Commercial image catalogues therefore use manual annotation and rely on text retrieval techniques for searching particular images. However, such an annotation has following main drawbacks:

First, the annotation depends on the person who adds it. User's perceptions of images vary to a large extent and different users may perceive different meanings from the same image. Even if the two users do have the same perception of an image, they may use different keywords to annotate the image, depending on the individual vocabularies. Naturally the result may vary from person to person and furthermore may depend on the context.

The second problem with manual annotation is that it is very time consuming. While it may be worthwhile for commercial image collections, it is prohibitive for indexing of images within the World Wide Web. One could not even keep up with the growth of available image data.

Third major drawback is that the user of a Text Based Image Retrieval must describe an image using nearly the same keywords that were used by the annotator in order to retrieve that image. Due to all these drawbacks, Content Based Image Retrieval is introduced [16].

B. Content Based Image Retrieval

The earliest use of the term *content-based image retrieval* in the literature seems to have been by Kato et.al.[43], to describe his experiments into automatic retrieval of images from a database by color and shape feature. The term has since been widely used to describe the process of retrieving desired images from a large collection on the basis of features (such as color, texture and shape) that can be automatically extracted from the images themselves.

A Content Based Image Retrieval (CBIR) is an interface between a high level system (the human brain) and a low level system (a computer). The human brain is capable of performing complex visual perception, but is limited in speed while a computer is capable of limited visual capabilities at much higher speeds. 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. Recent Content Based Image Retrieval research tries to combine both of these above mentioned approaches (Text Based Image Retrieval and Content Based Image Retrieval) and has developed efficient image representations and data models, query-processing algorithms, intelligent query interfaces and domain-independent system architecture.

The typical CBIR system performs two major tasks. The first one is feature extraction (FE), where a set of features, called image signature or 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, typically of the order of hundreds of elements (rather than millions). 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 [3], [13], [14], [15]

C. Similarity Measures

Finding good similarity measures between images based on some feature set is a challenging task. On the one hand, the ultimate goal is to define similarity functions that match with human perception, but how humans judge the similarity between images is a topic of ongoing research. Many Current Retrieval systems take a simple approach by using typically norm-based distances (e.g., Euclidean distance [2]) on the extracted feature set as a similarity function. The main premise behind these CBIR systems is that given a "good set" of features extracted from the images in the database (the ones that significantly capture the content of images.) then for two images to be "similar" their extracted features have to be "close" to each other.

The Direct Euclidian Distance between an image P and query image Q can be given as the equation below.

$$ED = \sum_{i=1}^{n} \sqrt{(Vpi - Vqi).(Vpi - Vqi)} \quad (1)$$

where, Vpi and Vqi be the feature vectors of image P and Query image Q respectively with size 'n'.

D. Applications of CBIR

A wide range of possible applications for CBIR technology has been identified. Some of these are listed below. (the type of visual information considered is given in brackets)

- art galleries, museums, archaeology (typically paintings or objects in front of a homogeneous background) [23],[24], [25], [26]
- architecture/engineering design (technical drawings),
- geographic information systems, weather forecast, (aerial/astronomical images) [27],[28]
- medical imaging (2D/3D data) [27[,[28]
- fashion/graphic design/advertising (typically objects in front of homogeneous or complex background)
- publishing (any image type for illustrating the text)

- trademark databases (icons, binary images, or images containing only few homogeneous colors) [29], [30], [31], [32]
- criminal investigations (e.g. fingerprint matching, copyright violation on the Internet, face recognition) [33],[34]
- picture archiving and retrieval, as well as database maintenance in general, e.g. removal of duplicates (very general image content)
- video archiving and access (very general video content) [35]
- image search on the Internet (very general image content) [36], [37].

Many of these application areas impose several restrictions on the type of image data, so that a priori knowledge can be incorporated in the retrieval process. For the retrieval of general image data, no priori knowledge can be identified; hence, a *visual appearance-based similarity* criterion is decisive. However, many authors of existing systems neglect a clear definition of feature vector. Therefore we doubt, that their good performance can be transferred from one dataset to an arbitrary other one.

As stated before, image retrieval covers many different fields of research. The focus is laid on the efficient construction and matching of objective image features. Especially we present some improvements that may be generally applied to Block Truncation Coding (BTC).

E. Kekre's LUV Color Space [38],[47]

Here we have used Kekre's LUV color Space. Where L gives luminance and U and V gives chromaticity values of color image. Negative value of U indicates prominence of red component in color image and negative value of V indicates prominence of green component over blue.

To get Kekre's LUV components we need the conversion of RGB to LUV components. The RGB to LUV conversion matrix given in equation 2 gives the L, U, V components of color image for respective R, G, B components.

$$\begin{vmatrix} L \\ U \\ V \end{vmatrix} = \begin{vmatrix} 1 & 1 & 1 \\ -2 & 1 & 1 \\ 0 & -1 & 1 \end{vmatrix} . \begin{vmatrix} R \\ G \\ B \end{vmatrix} \qquad (2)$$

The LUV to RGB conversion matrix given in equation 3 gives the R, G, B components of color image for respective L, U, V components.

$$\begin{vmatrix} R \\ G \\ B \end{vmatrix} = \begin{vmatrix} 1 & -2 & 0 \\ 1 & 1 & -1 \\ 1 & 1 & 1 \end{vmatrix} . \begin{vmatrix} L/3 \\ U/6 \\ V/2 \end{vmatrix} \qquad (3)$$

II. Block Truncation Coding (BTC)

The rapid expansion of the Internet and fast advancement in color imaging technologies have made digital color images more and more readily available to professional and amateur users. The large amount of image collections available from a variety of sources (digital camera, digital video, scanner, the internet etc.) has posed increasing technical challenges to computer systems to store/transmit and index/manage image data effectively to make such collections easily available. The storage and transmission challenge is tackled by image compression which has been studied for more than 30 years and significantly advancements have been made [1].

Many successful, efficient and effective image coding techniques have been developed and the body of literature on image coding is huge. Well developed and popular international standards on image coding have also long been available and widely used in many applications. The challenge to image indexing/management is studied in the context of image database, which has also been actively researched by researchers from a wide range of disciplines including those from computer vision, image processing and traditional database areas for over a decade.

One particularly promising approach to image database indexing and retrieval is the query by image content (QBIC) method. Whereby the visual contents of the images such as color distribution (color histogram), texture attributes and other image features are extracted from the image using computer vision/image processing techniques and used as indexing keys. In an image database, these visual keys are stored along with the actual imagery data and image retrieval from the database is based on the matching of the models visual keys with those of the query images. Because extra information has to be stored with the images, traditional approach to QBIC is not efficient in terms of data storage. Not only it is inefficient it is also inflexible in the sense that image matching / retrieval can only based on the pre-computed set of image features [1],[13].

Many image coding methods developed over the years are essentially based on the extraction and retention of the most important (visual) information of the image. The retained important information such as DCT coefficients of JPEG can be used for image indexing and object recognition. However since JPEG and other similar methods are not explicitly designed for image indexing purpose models and features have to be derived from the transform coefficients, which generally involves complicated and complex computation and also leads to an expansion of data. For example, it has been demonstrated that color is an excellent cue for image indexing. However it is difficult to explicitly exploit color information from the transform coefficients without decoding [1], [13].

On the other hand, non-transform based image coding can have image features such as color more easily available. For example, recent work on color image coding using vector quantization has demonstrated that color as well as pattern information can be readily available in the compressed image stream (without performing decoding) to be used as image indices for effective and efficient image retrieval (i,e image indexing using a colored pattern appearance model.)

Block truncation coding (BTC) is a relatively simple image coding technique developed in the early years of digital imaging more than 29 years ago. Although it is a simple technique, BTC has played an important role in the history of digital image coding in the sense that many advanced coding techniques have been developed based on BTC or inspired by the success of BTC [1].

Block Truncation Coding (BTC) was first developed in 1979 for grayscale image coding [1]. This method first divides the image to be coded into small non-overlapping image blocks (typically of size 4× 4 pixels to achieve reasonable quality). The small blocks are coded one at a time. For each block, the original pixels within the block are coded using a binary bit-map the same Upper Mean Color UMsize as the original blocks and two mean pixel values. In the original implementation the block mean and the variance of the pixels are used to preserve the first and second moment of the blocks. The descriptors here follow a later version of BTC, which was shown to give better performance [1].

The method first computes the mean pixel value of the whole block and then each pixel in that block is compared to the block mean. If a pixel is greater than or equal to the block mean, the corresponding pixel position of the bitmap will have a value of 1 otherwise it will have a value of 0. Two mean pixel values one for the pixels greater than or equal to the block mean and the other for the pixels smaller than the block mean are also calculated. At decoding stage, the small blocks are decoded one at a time. For each block, the pixel positions where the corresponding bitmap has a value of 1 is replaced by one mean pixel value and those pixel positions where the corresponding bitmap has a value of 0 is replaced by another mean pixel value.

It was quite natural to extend BTC to multispectrum images such as color images. Most color images are recorded in RGB space, which is perhaps the most well-known color space. As described previously, BTC divides the image to be coded into small blocks and code them one at a time. For single bitmap BTC of color image, a single binary bitmap the same size as the block is created and two colors are computed to approximate the pixels within the block. To create a binary bitmap in the RGB space, an inter band average image (IBAI) is first created and a single scalar value is found as the threshold value. The bitmap is then created by comparing the pixels in the IBAI with the threshold value [1].

A. BTC Based CBIR

Block truncation coding (BTC) was first developed in 1979 for grayscale image coding. And it was quite natural to extend BTC to multispectral images such as color images [1], [13]. The method divides the image into R, G, and B components. Then computes interband average image (IBAI) which is the average of all components (R, G, and B) and mean of interband average image is taken as threshold.

The bitmap is then created by comparing each pixel with this threshold value. If a pixel in the interband average image is greater than or equal to the threshold, the corresponding pixel position of the bitmap will have a value of 1 otherwise it will have a value of 0. Two mean colors one for the pixels greater than or equal to the threshold and other for the pixels smaller than the threshold are also calculated [1] , [13].

Let X={R(i,j),G(i,j),B(i,j)} where i=1,2,….m and j=1,2,….,n; be an m×n color image in RGB space.

The the interband average image could be computed as IA={IB(i,j) } where i=1,2,---,m and j=1,2,-----,n and where

$$IB(i,j)=\frac{1}{3}[(R(i,j)+G(i,j)+B(i,j))] \quad (4)$$

The threshold (T) is computed as the mean of IB(i,j) .

$$T=\frac{1}{m\times n}\sum_{i=1}^{m}\sum_{j=1}^{n}IB(i,j) \quad (5)$$

The binary bitmap {BM(i,j,)} with i=1,2,….,m and j=1,2,….,n is computed as

$$BM(i,j)=\{\begin{matrix}1, if....IB(i,j)>=T\\ 0,....if...IB(i,j)<T\end{matrix} \quad (6)$$

After the creation of the bitmap, two representative (mean) colors are then computed. The two mean colors, Upper Mean and Lower Mean. The Upper Mean UM=(R_{m1}, G_{m1}, B_{m1}) is computed as following equations

$$Rm1=\frac{1}{\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)}.[\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)\times R(i,j)] \quad (7)$$

$$Gm1=\frac{1}{\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)}[\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)\times G(i,j)] \quad (8)$$

$$Bm1=\frac{1}{\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)}[\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)\times B(i,j)] \quad (9)$$

The Lower Mean LM= (R_{m2}, G_{m2}, B_{m2}) is computed as following equations

$$Rm2=\frac{1}{m\times n-\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)}[\sum_{i=1}^{m}\sum_{j=1}^{n}\{1-BM(i,j)\}\times R(i,j)] \quad (10)$$

$$Gm2=\frac{1}{m\times n-\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)}[\sum_{i=1}^{m}\sum_{j=1}^{n}\{1-BM(i,j)\}\times G(i,j)] \quad (11)$$

$$Bm2=\frac{1}{m\times n-\sum_{i=1}^{m}\sum_{j=1}^{n}BM(i,j)}[\sum_{i=1}^{m}\sum_{j=1}^{n}\{1-BM(i,j)\}\times B(i,j)] \quad (12)$$

Now these Upper Mean and Lower Mean together will form a feature vector or signature of the image. For every image stored in the database these feature vectors are computed and stored in feature vector table.

Whenever a query image is given to CBIR, again the feature vector for query image will be computed and then it will be matched with feature vector table entries for best possible matches at given accuracy rate.

Here we have used Direct Euclidean Distance as a similarity measure to compute the similarity measures of images for Content Based Image Retrieval applications [2], [16]. Details of Euclidean Distances are given in section I-C.

B. CBIR using BTC-LUV

In original BTC we divide the image into R, B, and G components and compute the interband average image (IBAI) which is the average of all the components(R, G, and B) and mean of interband average image is taken as threshold. But the disadvantage of this method is that if one of the component is prominent than the other component then that component dominates the threshold value, reducing the effect of other component.

In BTC-LUV we convert RGB components into Kekre's LUV and then consider L, U, V components to compute three different thresholds and then apply BTC to each individual L, U and V planes. Let the thresholds be TL, TU and TV, which could computed as per the equations given below.

$$TL = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} L(i,j) \tag{13}$$

$$TU = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} U(i,j) \tag{14}$$

$$TV = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} V(i,j) \tag{15}$$

Here three binary bitmaps will be computed as BMl, BMu and BMv. If a pixel in each component (L,U and V) is greater than or equal to the respective threshold, the corresponding pixel position of the bitmap will have a value of 1 otherwise it will have a value of 0.

$$BMl(i,j) = \begin{cases} 1, if \ldots L(i,j) >= TL \\ 0, \ldots if \ldots L(i,j) < TL \end{cases} \tag{16}$$

$$BMu(i,j) = \begin{cases} 1, if \ldots U(i,j) >= TU \\ 0, \ldots if \ldots U(i,j) < TU \end{cases} \tag{17}$$

$$BMv(i,j) = \begin{cases} 1, if \ldots V(i,j) >= TV \\ 0, \ldots if \ldots V(i,j) < TV \end{cases} \tag{18}$$

Two mean colors one for the pixels greater than or equal to the threshold and other for the pixels smaller than the threshold are also calculated [1] , [15]. The upper mean color UM(Lm1,Um1,Vm1) is given as follows

$$Lm1 = \frac{1}{\sum_{i=1}^{m} \sum_{j=1}^{n} BMl(i,j)} [\sum_{i=1}^{m} \sum_{j=1}^{n} BMl(i,j) \times L(i,j)] \tag{19}$$

$$Um1 = \frac{1}{\sum_{i=1}^{m} \sum_{j=1}^{n} BMu(i,j)} [\sum_{i=1}^{m} \sum_{j=1}^{n} BMu(i,j) \times U(i,j)] \tag{20}$$

$$Vm1 = \frac{1}{\sum_{i=1}^{m} \sum_{j=1}^{n} BMv(i,j)} [\sum_{i=1}^{m} \sum_{j=1}^{n} BMv(i,j) \times V(i,j)] \tag{21}$$

The Lower Mean LM= (L_{m2}, U_{m2}, V_{m2}) is computed as following equations

$$Lm2 = \frac{1}{m \times n - \sum_{i=1}^{m} \sum_{j=1}^{n} BMl(i,j)} [\sum_{i=1}^{m} \sum_{j=1}^{n} \{1 - BMl(i,j)\} \times L(i,j)] \tag{22}$$

$$Um2 = \frac{1}{m \times n - \sum_{i=1}^{m} \sum_{j=1}^{n} BMu(i,j)} [\sum_{i=1}^{m} \sum_{j=1}^{n} \{1 - BMu(i,j)\} \times U(i,j)] \tag{23}$$

$$Vm2 = \frac{1}{m \times n - \sum_{i=1}^{m} \sum_{j=1}^{n} BMv(i,j)} [\sum_{i=1}^{m} \sum_{j=1}^{n} \{1 - BMv(i,j)\} \times V(i,j)] \tag{24}$$

These Upper Mean and Lower Mean together will form a feature vector or signature of the image, which could be used for CBIR in the same manner as shown in section II-A.

C. CBIR using Spatial BTC-LUV

Here the BTC-LUV is further boosted with spatial considerations. For feature vector extraction here the image is divided into four equal sized, non overlapping quadrants. For every quadrant the BTC-LUV feature extraction is applied and features are stored. The size of feature vector in Spatial BTC-LUV is four times to that of BTC-LUV. As a result of the spatial consideration and more number of feature descriptors the precision of CBIR using Spatial BTC-LUV is higher than the BTC and BTC-LUV discussed earlier in this paper.

III. IMPLEMENTATION

The implementation of the three CBIR techniques is done in MATLAB 7.0 using a computer with Intel Core 2 Duo Processor T8100 (2.1GHz) and 2 GB RAM.

A. The Image Database

The CBIR techniques are tested on the image database[20] of 1000 variable size images spread across 11 categories of human being, animals, natural scenery and manmade things. The categories and the distribution of the images is shown in table 1.

TABLE I
DATABASE IMAGE DISTRIBUTION

Category	Number of Images
Tribal People	85
Buses	99
Beaches	99
Dinosaurs	99
Elephants	99
Roses	99
Horses	99
Snow Mountains	61
Airplanes	100
Historical Monuments	99
Sunrise Scenery	61

To compare the techniques and to check their performance we have used the precision and recall.

B. Retrieval Accuracy

In [21] Jain et al. address some of the features of an efficient CBIR system such as accuracy, stability and speed. To assess the retrieval effectiveness, we have used the precision and recall as statistical comparison parameters for the BTC, BTC-RGB and Spatial BTC-RGB techniques of CBIR. The standard definitions of these two measures are given by following equations.

$$\Pr ecision = \frac{Number\_of\_relevant\_images\_retrieved}{Total\_number\_of\_images\_retrieved} \quad (25)$$

$$\text{Re}\,call = \frac{Number\_of\_relevant\_images\_retrieved}{Total\_number\_of\_relevent\_images\_in\_database} \quad (26)$$

These two parameters are plotted against the percentage of accuracy which is defined as follows.

$$Percentage.Accuracy = \frac{[255 - ED]}{255} \times 100 \quad (27)$$

Note that when ED (Euclidian Distance) is maximum i.e.255, accuracy is zero and when ED is zero accuracy is 100 percent.

IV. RESULTS AND DISCUSSION

The methods BTC, BTC-LUV and Spatial BTC-LUV were applied to the image database of 1000 images. For eleven query images (one from each category from database) the precision is calculated for all three methods and the average precision is plotted against the percentage accuracy as shown in Fig. 1. The precision is 100 % in case of Spatial BTC-LUV even at the accuracy rate of 97 %, while the precision is sent percent till 99 % accuracy in BTC-LUV and only at 100 % accuracy in conventional BTC. Overall for percentage accuracy of 86 % and more the precision of Spatial BTC-LUV is greater than the precision of other two methods This shows that Spatial BTC-LUV outperforms BTC-LUV and BTC.

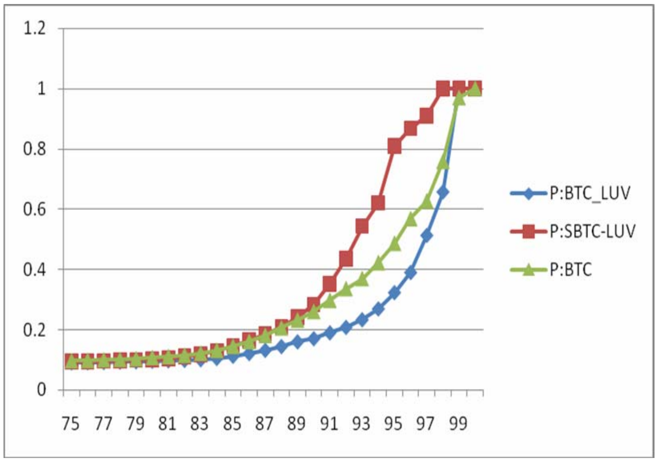

Fig. 1. Precision versus Percentage Accuracy

The conclusion that BTC-LUV is better than BTC could be drawn from Fig. 2, where average recall is plotted against percentage accuracy for eleven query images (eleven categories and total 1000 images in database). Here recall rates are lowest in Spatial BTC-LUV, moderate in BTC and highest in BTC-LUV for the same percentage of accuracy.

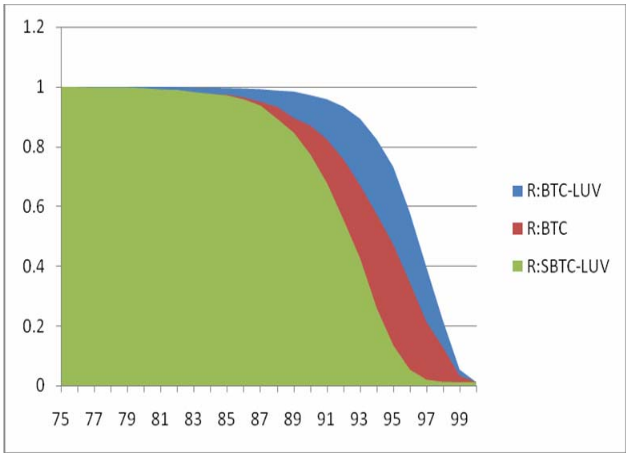

Fig. 2. Recall versus Percentage Accuracy

Fig. 3 shows both precision and recall plotted against percentage of accuracy for all three methods. Here we can observe that Spatial BTC-LUV is performing better (with crossover value 0.50) than BTC-LUV (0.44) and BTC (0.38). So finally we can state that if precision and recall both are considered Spatial BTC-LUV and BTC-LUV gives better image retrieval than conventional BTC, while Spatial BTC-LUV is the best among three techniques discussed in the paper.

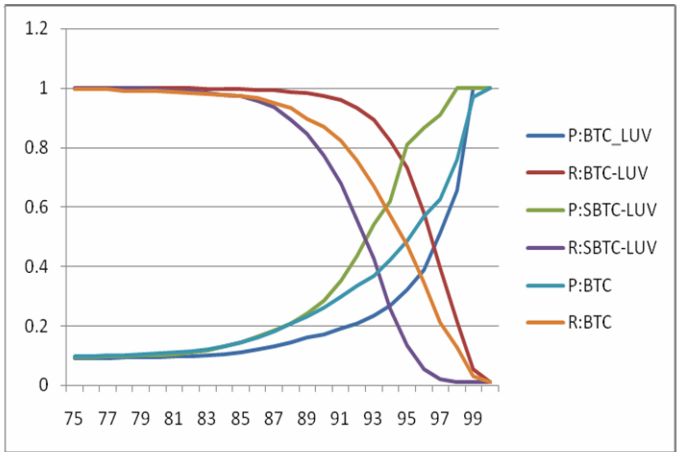

Fig. 3. Precision and Recall versus Percentage Accuracy

Fig. 4 shows a sample query image from dinosaur category of database. The retrieval technique Spatial BTC-LUV is applied on it. Fig. 5 shows the result as the set of retrieved images from the database with percentage accuracy of 92. The green shading in result shows that the query image itself is retrieved and yellow shading shows the wrong result images. Here the precision and recall approximately are 97 % and 87 % respectively.

Fig. 4. Query Image from Dinosaurs

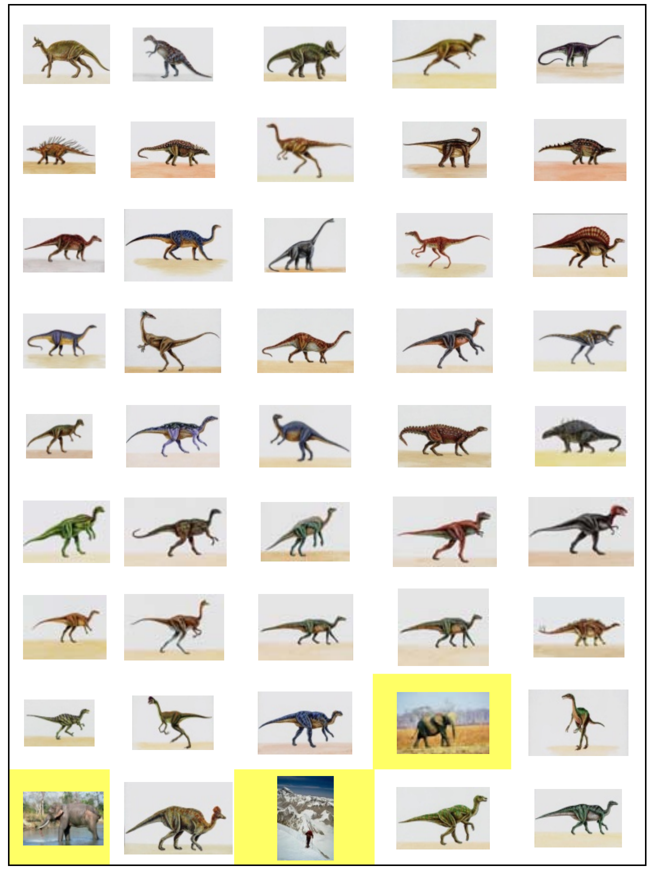

Fig. 5. Result Image Set of Spatial BTC-LUV Technique applied to Query Image shown in Fig.4

V. Conclusion

Now a day we are living in the information age, where because of advent of the technology there is a situation like information explosion. Images have giant share in this information . More précised retrieval techniques are needed to access the large image achieves being generated, for finding relatively similar images.

Here in this paper we have used BTC which was developed for grayscale image coding. Modified BTC is used along with Kekre's LUV color space to get new CBIR techniques as BTC-LUV and Spatial BTC-LUV. BTC-LUV outperforms conventional BTC if only recall is considered. The results show that Spatial BTC-LUV performs better if precision and recall both are considered together.

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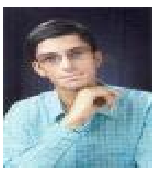

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