Features Extraction using Local Binary Patterns and Steerable Pyramids for Efficient Image Retrieval

Poonam Rani
Department of Computer Science and Engineering
Shaheed Bhagat Singh State Technical Campus
Ferozepur, India

Sonika Jindal
Department of Computer Science and Engineering
Shaheed Bhagat Singh State Technical Campus
Ferozepur, India

ABSTRACT
This present a hybrid approach of image classification using KNN and feature extraction using LBP and steerable pyramid based image retrieval system that uses color, contours and texture as visual features to describe the content of an image. In this k-nearest neighbor image classification mechanism is used to fetch the appropriate images from the database image set using the query image and the database images are reduced to images returned after classification mechanism which leads to decrease in the number of irrelevant images. Steerable pyramid applied to extract features from query image and candidate images retrieved from the KNN and store them in feature features. Local Binary Pattern (LBP) is one of the techniques used in image classification and has been used for extracting the shape of the images. The experimental evaluation of the system is based on a Wang data set. Various parameters like precision, recall, computation time and matching time have been computed to analyze the results that are recorded iteratively for different images as input. From the experimental results, it is evident that proposed system performs significantly better and faster compared with other existing systems. The results demonstrate that each type of feature is effective for a particular type of images according to its semantic contents, and using a combination of them giving better retrieval results for almost all different classes of images in the data set.

Keywords
CBIR, Colour histogram, Colour, shape, texture, LBP, KNN, Steerable pyramid.

1. INTRODUCTION
Content-based image retrieval (CBIR) has turned into a critical research territory in PC vision as advanced picture accumulations are quickly being made and made accessible to large numbers of clients through the World Wide Web. There are accumulations of pictures from workmanship historical centers, medicinal foundations, and natural organizations, to give some examples. In the business segment, organizations have been shaped that are making huge accumulations of photographic pictures of certifiable scenes accessible to clients who need them for representations in books, articles, promotions, and other media implied for people in general on the loose. Content-Based Image Retrieval (CBIR) frameworks are web indexes for picture databases, which list pictures as indicated by their substance. An ordinary errand tackled by CBIR frameworks is that a client presents an inquiry picture or arrangement of pictures and the framework is required to recover pictures from the database as comparative as could be allowed. Another assignment is a help for perusing through expansive picture databases, where the pictures should be gathered or sorted out as per comparable properties [1]. alleged semantic hole, which is the distinction between data that can be extricated from the visual information and the translation that similar information have for a client in a given circumstance. The other reason is called tangible hole, which is the contrast between a genuine protest and its computational portrayal got from sensors, which estimations are fundamentally impacted by the obtaining conditions. In a regular CBIR framework, picture low level highlights like shading, surface, shape and spatial areas are spoken to as a multidimensional component vector. The element vectors of pictures in the database frame an element database. The recovery procedure is started when a client questions the framework utilizing an illustration picture or outline of the protest. The question picture is changed over into the inward portrayal of highlight vector utilizing a similar element extraction schedule that was utilized for building the element database [2] [3].

The closeness measure is utilized to compute the separation between the component vectors of question picture and those of the objective pictures in the element database. At last, the recovery is performed utilizing an ordering plan which encourages the productive seeking of the picture database. As of late, client's significance input is additionally joined to additionally enhance the recovery procedure with a specific end goal to create perceptually and semantically more important recovery comes about. Content-based picture recovery look into has delivered various web indexes. The business picture suppliers, generally, are not utilizing these procedures. The primary reason is that most CBIR frameworks require a case picture and after that recover comparable pictures from their databases. Genuine clients don't have illustration pictures; they begin with a thought, not a picture. Some CBIR frameworks enables clients to draw the outline of the pictures needed. Such frameworks require the clients to have their goals as a main priority first and accordingly must be connected in some specific spaces, similar to trademark coordinating, and painting buying. Prior CBIR frameworks depend on worldwide picture highlights, for example, shading histogram and surface insights. Worldwide highlights can't catch question properties, so nearby highlights are favored for protest class acknowledgment. For a similar reason, more elevated amount picture highlights are wanted to bring down level ones. Comparable picture components, similar to pixels, fixes, and lines can be assembled together to shape larger amount units, which will probably relate to items or question parts. Different sorts of highlights can be consolidated to enhance the component discriminability. For instance, utilizing shading and surface to distinguish trees is more dependable than utilizing shading or surface alone. The setting data is additionally useful for recognizing objects. A vessel hopeful district more probable relates to a watercraft on the off chance that it is inside a blue locale [4] [5].

While enhancing the capacity of our framework by outlining more elevated amount picture highlights and joining singular ones, we ought to be set up to apply an ever increasing number of highlights since a predetermined number of highlights can't fulfilling the prerequisite of perceiving numerous different protests in customary photographic pictures as a multidimensional element vector. The element vectors of pictures in the database frame an element database. The recovery procedure is started when a client question the framework utilizing a case picture or portray of the protest. The inquiry picture is changed over into the interior portrayal of highlight vector utilizing a similar element extraction schedule that was utilized for building the element database. The similitude measure is utilized to compute the separation between the element vectors of question picture and those of the objective pictures in the element database. At long last, the recovery is performed utilizing an ordering plan which encourages the productive seeking of the picture database. The thought is that all highlights will be locales, each with its own arrangement of qualities, however with a typical portrayal. This uniform portrayal empowers our framework to deal with various different highlight sorts and to be extendable to new highlights whenever [6].

2. RELATED WORK

A few studies have been completed on the content based image retrieval in past few years. Some papers contain feature extraction techniques some contain feature matching and some provide classifications of images on the basis of their features

In this paper Amandeep Khokher et al. [7] introduces contents of images (shape, color, texture etc.) on the basis of which image is analyzed. In this paper different techniques of feature extraction methods like color models, color moments, tamura fetures and wavelet transforms are discussed.

Savita Gandhi et al. [8] presented content based image retrieval by combining the low level features. In this firstly transforming color space from RGB model to HSV model, texture feature are obtained by using block difference of inverse probability and block based local correlation moments and at last canny edge detection for shape feature and final results are obtained by calculating precision and recall.

D.Jayabharathi et al. [9] analyses the performances of feature extraction techniques PCA, LDA and ICA and classification techniques NN and SVM. In this paper performance evaluated on the basis of recognition rate and F-score and observed better results of recognition rate with PCA and SVM.

Hui Xie et al.[10] proposed a forward an analogy-relevance feedback CBIR methods which use multiple methods, in this user give query image and system gives multiple analogy-RF images in sample database and these analogy-RF images are used for revise purpose and this give better result for COREL 1k images.

Yixin Chen et al.[14] gives a new technique, round up the similar image by cluster-based retrieval of images by unsupervised learning (CLUE), for improving user interaction with image retrieval systems by fully exploiting the similarity information. CLUE retrieves image bundles by applying a graph-theoretic clustering algorithm to a collection of images in the vicinity of the query. Clustering in CLUE is dynamic.

In this paper Savvas A. Chatzichristofis et al. [15] proposed "color and edge directivity descriptor" algorithm which convert the color and texture information to the histogram and ANMRR measure is used to evaluate the performance of proposed method.

Chuen-Horng Lin et al. [16] proposes the extraction of three basic features first is color by the color co-occurrence matrix, second is difference between pixels of scan pattern and third color distribution called color histogram for K-mean value. In this work he proposed multiple comparisons and analyses on the three type of database for the better results. .

Sreedevi S et al. [18] proposed feature level algorithm which classify the different types of images to different levels and the features are extracted at different level to retrieve the results, after leveling the system retrieve images from new leveled database for the faster process.

Sandeep Kumar et al [19] introduces a parallel approach to the morphological images because the database images are increasing very fast so to handle that he gave the idea of parallel approach which gives better results.

Komal Juneja et al. [20] presented an efficient method of searching, locating and retrieving of images from huge collection of data which is increasing day by day. This gives best idea to increase speed of retrieval system.

Soundararajan Ezekiel et al. [21] analyzed two methods first contourlet transformations with pulse coupled neural network and second is rescaled range analysis, the first method is similar to the wavelet method but it is simpler, faster and combination of both gives better results.

James Z.Wang et al. [22] presented an image retrieval system based on semantic classification method, wavelet approach for the feature extraction, integrated region matching based on image segmentation. In this, images are classified as textured or non-textured, graphs, photographs etc. and on the basis of groups the overall search limited to the particular interested segment region therefore accuracy of result is achieved.

Michal Perdoch et al. [24] proposes an innovative method for solving the problem of limiting factor because each feature of each image of database is stored at unique address so to handle this, gravity vector assumption is used which gives batter results.

Herve Jegou et al. [25] focuses on the three constraints accuracy, efficiency and storage. In this first of all clustering the images than indexing by preserving the quality of images, which gives better results.

Relja Arandjelovi´c et al. [26] proposed a method to retrieve image result immediately as video google by doing comparison with SIFT descriptor, by expansion of query information and improve image augmentation by Turcot and Lowe. The combination of these improves efficiency as well accuracy of retrieval system.

Bhavneet Kaur et al. [27] used the OPEN CV platform since it provides a C interface to implement various image processing algorithms. The work merges the feature extraction technique with this most suitable platform available for image algorithms.

3. MOTIVATION OF THE WORK

In the last two decades, researcher give a lot to the field of CBIR, However, there still remain some problems which have not been answered satisfactorily. First and prime problem is the semantic gap, which exist between low level feature representation of images and the actual visual perception of the image. Researchers all over the world are working in the direction of narrowing down this semantic gap. Semantic gap

is an enormous problem which can be seen as a collection of many small problems. In this work, we have identified such problems and tried to provide an effective solution to these problems.

Many of the existing systems attempt to compare the query image with every target image in the database to find the top matching images, resulting in an essentially linear search, which is prohibitive when the database is large. This believed that it is not necessary to conduct a whole database comparison. In fact, it is possible to exploit a previous information regarding the "organization" of the images in the database in the feature space before a query is awkward, such that when a query is received, only a part of the database needs to be searched, while a large portion of the database may be eliminated in the search. This exactly saves significant query processing time without compromising the retrieval precision. To speed up the retrieval process, the database images are segmented into distinct regions. A clustering algorithm, definitely the self-organizing map (SOM), is used to cluster the image regions into groups. Regions with similar features are grouped together in the same class. This clustering process is performed, and each region's indexing data along with its associated class ID is recorded in the index files. To find result similar to a query, the query image is segmented into its regions. The distances between each query region and all class regions in the database is computed to determine which class of these query regions belong. The similar regions in the database are returned and all the images that have any of these regions are assigned as candidates (new database). The query image is compared to the new database image set instead of being compared to the whole database image. The main highlights of the problem formulation are as follows:

- A large number images are presented in database so it is very time consuming to evaluate feature of each image and compare with query image.
- More number of comparisons require more hardware thereby increasing the cost.
- The semantic gap between the user's needs and the capability of CBIR algorithms, significant efforts should be done to eliminate this semantic gap.

4. PROPOSED METHOD

A hybrid approach of image classification using KNN and feature extraction using LBP and steerable pyramid based image retrieval system that uses color, contours and texture as visual features to describe the content of an image proposed. Initially k-nearest neighbor image classification mechanism used to fetch the appropriate images from the database image set using the query image and the database images are reduced to images returned after classification mechanism which leads to decrease in the number of irrelevant images. This process is performed before query matching takes place. Therefore to answer a query proposed system does not need to search the entire database images; instead just a number of candidate images are required to be searched for image similarity. Further steerable pyramid to extract features from query image and candidate images retrieved from the KNN applied and store them in feature features.

4.1 K Nearest Neighbour

An instance based learning method called the K-Nearest Neighbor or K-NN algorithm has been used in many application areas such as data mining, statistical pattern recognition, image processing etc. The purpose of KNN is to evaluate the distance of each image first by calculating the centroid, if the image (object) has distance less than the mean value (which given by algorithm) than it is under the classified folder if more than mean value than it is under un classified folder, now classified folder images act as new database images for this retrieval system. this classification technique in our retrieval system reduce the computation time by minimizing the region of search after creating new database folder[9].

4.2 Local Binary Pattern

The local binary pattern is optical descriptor used for classify the computer vision. It has been noted that if local binary pattern is combined with histogram oriented gradients it give more accurate results. Local binary pattern is defined as to sum up the local structure of an image by comparing the neighbor pixels with central pixel value. In this divide the window into 3x3 matrices and now focus on each and every matrix of window cell one by one to evaluate the decimal equivalent for each matrix, to calculate decimal equivalent for each matrix, firstly look at the center pixel value and now compare each neighborhood with this center value if it is greater or equal to center value than assign it to 1 otherwise 0 as shown below in Figure 1.

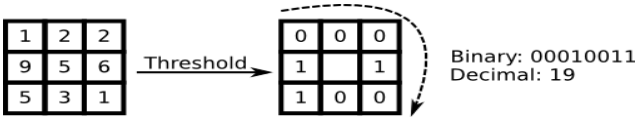

Figure 1: Conversion of 3x3 matrix to decimal value.

Now use the clockwise or anticlockwise rule to arrange binary values into a sequence and calculate the decimal equivalent for this binary value by applying (2^0x1+2^1x1+2^2x0+…..) will be equal to 19 for above matrix.

4.3 Steerable Pyramids

The Steerable Pyramid is a multi-scale, multi-oriented image decomposition mechanism that offers a beneficial front-give up for image analysis, processing and computer imaginative and vision based applications. This mechanism was developed in 1990, so as to bypass the restrictions of orthogonal separable wavelet decompositions that were then becoming famous for image processing (mainly, those representations are heavily aliased, and do no longer represent oblique orientations properly). Once the orthogonality impact is dropped, it makes experience to completely rethink the filter design problem (as opposed to simply re-using orthogonal wavelet filters in a redundant illustration, as is accomplished in cycle-spinning or un-decimated wavelet transforms!).

The functions of the steerable pyramid are Kth-order directional derivative operators, that are available in distinctive sizes and K+1 orientations. As directional derivatives, they span a rotation-invariant subspace, and they are designed and sampled such that the entire transform forms a decent frame. This steerable pyramid consists of 4 orientation sub bands. The smallest sub band is the residual low pass records. The residual high pass sub band isn't always proven. The block diagram for the decomposition (each analysis and synthesis) is proven to the right. Initially, the photo is separated into low and high pass sub bands, the use of filters L0 and H0. The low pass sub band is then divided into a fixed of orientated band pass sub bands and a lower-skip sub band. This lower bypass sub band is subsampled by means of a thing of 2 inside the X and Y directions. The recursive (pyramid) creation of a pyramid is achieved through inserting a copy of the shaded portion of the diagram at the

location of the stable circle (i.e., the low pass department).

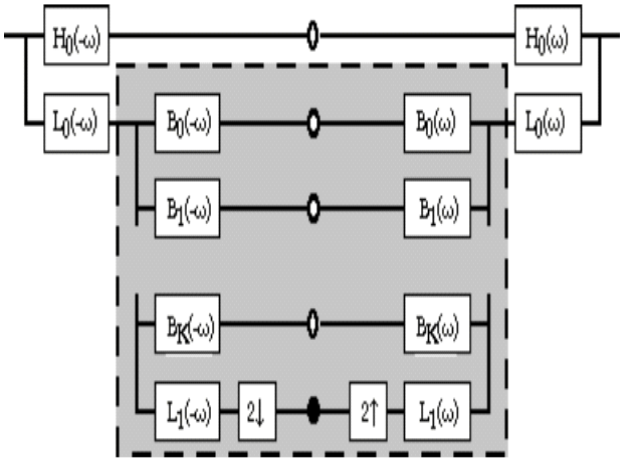

Figure 2. Decomposition using Steerable Pyramids

5. RESEARCH METHODLOGY

- First of all focus on single query image in the query folder and rest of the images are database images
- Extract the low level features like color, shape and texture of all database as well as query image.
- Match all the database images with the query images by using KNN. Then the result will comes as classified images and unclassified images. Classified images are stored in labeled folder and unclassified images are stored in unlabeled folder.
- Apply Steerable Pyramid and LBP on classified images
- Then Match the classified images with query images and display output.

6. EXPERIMENTAL SETUP

WANG Database contains 1000 images which can be classified into different domains namely Buses, Dinosaurs, Flowers, Building, Elephants, Mountains, Food, African people, Beaches and Horses with JPEG format which used in a general purpose for experimentation. These images are stored with size 256×256 and each image is represented with RGB color space. Few categories of WANG databse are shown in Figure 3.

Figure 3. WANG dataset images

6.1 OPENCV

The open source computer vision library, OpenCV, began as a research project at Intel in 1998. It has been available since 2000 under the BSD open source license. OpenCV is aimed at providing the tools needed to solve computer-vision problems. It contains a mix of low-level image-processing functions and high-level algorithms such as face detection, pedestrian detection, feature matching, and tracking.

6.2 Experimental Results

Multiple experiments have been conducted on different categories of images from the WANG dataset. The different categories like buses, buildings, flowers, elephants, mountains, dinosaurs, beaches, human and horses have been used for testing and analysis. A retrieved image is considered to be correct if and only if it is in the same category as the query. The experiments are carried out in a personal computer with Intel Core i3 processor with 4GB RAM. The program is developed using OpenCV libraries and Visual Studio IDE.

6.3 Performance Evaulation

The performance of a retrieval system is evaluated based on several criteria. Some of the commonly used performance measures are average precision, average recall, average retrieval rate. All these parameters are computed using precision and recall values computed for each query image [26].

6.3.1 Precision

The precision of the retrieval is defined as the fraction of the retrieved images that are indeed relevant for the query:

PRECISION = Number of relevant images retrieved / Total number of images retrieved from the database.

Table 1. Results evaluated after testing.

Category Name	Relevant After KNN	Irrelevant After KNN	Final Retrieved Images	Positive In Final Result	Negative In Final Result
Human	18	18	11	10	1
Beech	28	26	14	10	4
Building	25	22	7	6	1
Bus	31	23	15	15	0
Dinasour	17	19	7	7	0
Elephant	38	22	25	23	2
Flower	11	14	4	3	1
Horse	18	11	7	7	0
Mountain	40	35	17	12	5
Food	19	12	10	9	1

6.3.2 Recall

The recall is the fraction of relevant images that is returned by the query:

RECALL= Number of relevant images retrieved/Total number of relevant images in the database.

A good retrieval system should have high values for precision and recall. Different set of images are taken in each experiment. Table1 illustrates the results retrieved by running the multiple number of experiments. All the categories have been taken for testing purposes.

Table 2. Precision and Recall Values

Precision	Recall	Computation Time	Matching Time
0.9	0.4	617	2052
0.7	0.3	850	2143
0.9	0.2	918	4442
1.0	0.5	1216	4900
1.0	0.3	290	1242
0.9	0.6	1217	2810
0.8	0.2	199	2265
1.0	0.3	639	2436
0.7	0.2	1235	3701
0.9	0.4	687	3131

In the table 2, the precision and recall are calculated for the same set of images that are used in Table 1. The overall computation time and matching time is computed in milliseconds and has been optimized.

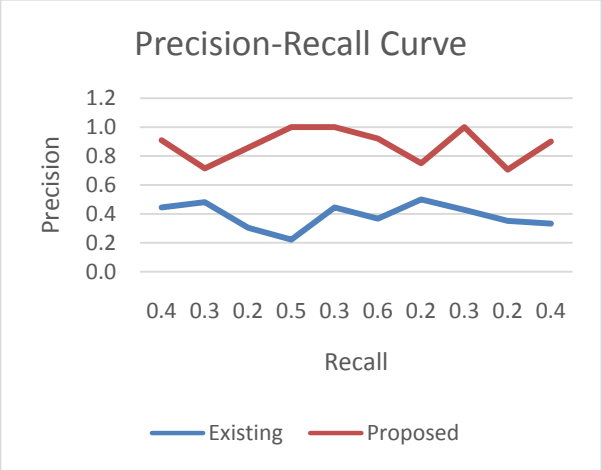

Figure 4. Precision-recall Curve of existing and proposed

Figure 4 depicts the precision comparison of the existing work and the proposed work. There is lot of improvement in the precision and recall in the present work. Improvement in precision means CBIR system is retrieving more number of relevant images.

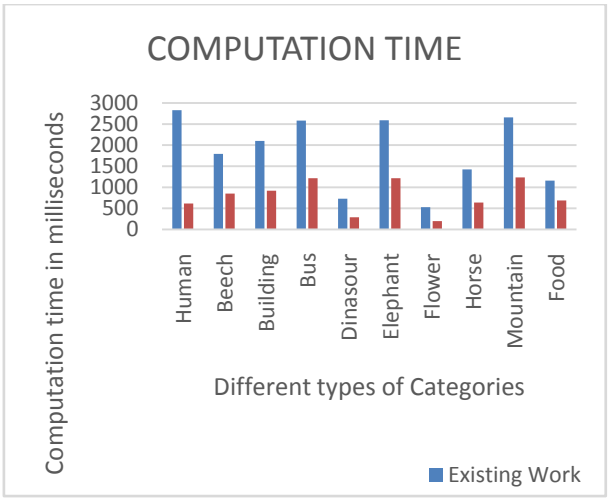

Figure 5. Computation time

Figure 5 explains the computation time comparison for the existing work and present work. The computation time is measured in milliseconds. In the proposed work, the computation time has been reduced substantially which shows the improvement.

7. CONCLUSION

Visual feature such as color, texture and contour are extracted using LBP and steerable pyramid. KNN has been applied to extract the irrelevant images and remove it from further processing. Features are extracted on both whole image level and database image level to better capture salient object descriptions. To negotiate the gap between low-level visual features and high-level concepts, median vector mechanism is applied and integrated with these content-based retrieval techniques in a vector space model. Experiments show that combining the color, texture and feature vector achieves the best performance in the comparison of various approaches. Finally, since it is obvious that neither single color feature nor textual features are sufficient to capture the overall contents of visual data, we propose a seamless integration of all the feature vectors such as color, texture and contour, taking advantage of using our vector space model. The combined feature vector, on which latent semantic indexing will be performed afterwards, is normalized and weighted. Preliminary results reveal that it is a very promising approach to further bridging the semantic gap and achieving better retrieval performance. After evaluating the results, we have reached up to the solution that we have been able to improve the CBIR mechanism using the proposed mechanism in this work. We will further test and benchmark this integrated image retrieval framework over various large image databases, along with tuning the relevance feedback to achieve optimal performance with highly reduced dimensionality.

8. REFERENCES

[1] M. Fakheri, T. Sedghi, M. . G. Shayesteh1 and M. C. Amirani, "Groundwork for image retrieval using machine learning and statistical similarity matching techniques," IET Image Process, pp. 1-11, 2013.

[2] P. MANIPOONCHELVI and K. MUNEESWARAN, "Multi region based image retrieval system," Indian Academy of Sciences, pp. 333-344, 2014.

[3] Savita Gandhani1, Rakesh Bhujade1 and Amit Sinhal1,"An improved and efficent implementation of

cbir system based on combined features" IET,pp.353-359,2013.

[4] Y. Chen, J. . Z. Wang and R. Krovetz, "CLUE: Cluster-Based Retrieval of Images by Unsupervised Learning," IEEE, pp. 1187-1201, 2005.

[5] R. Fergus, L. Fei-Fei, P. Perona and A. Zisserman, "Learning Object Categories from Google's Image Search," IEEE, 2005.

[6] Y. Chen, X. Li, A. Dick and A. v. d. Hengel, "Boosting Object Retrieval With Group Queries," IEEE, pp. 765-768, 2012.

[7] A.Khokher,R.Talwar"Content based image retrieval feature extraction and applications,"IJCA,pp 9-14,2012.

[8] Savita Gandhani1, Rakesh Bhujade1 and Amit Sinhal1,"An improved and efficent implementation of cbir system based on combined features" IET,pp.353-359,2013

[9] D.jeyabharathi and A.Suruliandil"Performance analysis of feature extraction and classification tech.,"ICCPCT", pp1211-1214,2013.

[10] H. Xie, Y. Ji and Y. Lu, "An Analogy-Relevance Feedback CBIR Method Using Multiple Features," IEEE, pp. 83-86, 2013.

[11] C.-H. Lin, R.-T. Chen and Y.-K. Chan, "A content-based image retrieval based on color and texture feature," ELSEVIER, p. 658–665, 2009.

[12] Y. Chen and J. Z. Wang, "A Region-Based Fuzzy Feature Matching Approach to Content-Based Image Retrieval," IEEE, pp. 1252-1267, 2002.

[13] K. BELATTAR and S. MOSTEFAI , "CBIR with RF:which Technique for which Image," IEEE conference 2013.

[14] Y. Chen, J. . Z. Wang and R. Krovetz, "CLUE: Cluster-Based Retrieval of Images by Unsupervised Learning," IEEE, pp. 1187-1201, 2005.

[15] Savvas A Chatzichristofis, Yiannis S Boutalis,"color and edge directivity descriptor", springer, pp.312-322, 2008.

[16] Chuen-horng lin "Image Retrieval Using Modified Color Variation Co-occurrence Matrix",IAE,pp.42-51,2008.

[17] Adrijit Basu"Shape Based Image Representation and Retrieval",IJERMT,2015,pp.81-86.

[18] Sreedevi S. and Shinto Sebastian, "Fast Image Retrieval with Feature Levels," IEEE, 2013.

[19]] S. Kumar, S. Jain and T. Zaveri, "Parallel Approach To Expedite Morphological Feature Extraction Of Remote Sensing Images For Cbir System," IEEE, pp. 2471-2474, 2014.

[20] K. Juneja, A. Verma , S. Goel and S. Goel , "A Survey on Recent Image Indexing and Retrieval Techniques for Low-level Feature Extraction in CBIR systems," IEEE, pp. 67-72, 2015.

[21] S. Ezekiel, Mark G. Alford, David Ferris and Eric Jones,, "Multi-Scale Decomposition of Content Based ge Retrieval," IEEE, 2013.

[22] J. Z. Wang, J. Li and G. Wiederhold, "SIMPLIcity: Semantics-Sensitive Integrated Matching for Picture LIbraries," IEEE, pp. 947-963, 2001.

[23] S. . A. Chatzichristofis and Y. S. Boutalis, "CEDD: Color and Edge Directivity Descriptor: A Compact Descriptor for Image Indexing and Retrieval," Springer-Verlag Berlin Heidelberg, pp. 313-322, 2008.

[24] M.Perdoch "Efficient representation of local geometry for large scale object retrieval"IEEE conference,2009.

[25] H.jegou,"Aggregating local descriptors into a compact image representation",IEEE conference,2010.

[26] Relja Arandjelovi"Three things everyone should know to improve object retrieval",IEEE conference,2010.

[27] B. Kaur and S. Jindal, "An implementation of Feature Extraction over medical images on OPEN CV Environment".

[28] S. M. H. Khan, A. Hussain and I. F. T. Alshaikhl, "Comparative study on Content-Based Image Retrieval (CBIR)," IEEE, pp. 61-66, 2013.