Optimized Content Based Image Retrieval Using Fusion of Multiple Features and Distance Metrics

Sayli Zope[1], Dr Dinesh D. Patil[2]

[1]PG Scholar, Shri sant Gadge College of Engineering, Bhusawal
[2]Associate Professor and Head of Department, Shri sant Gadge College of Engineering, Bhusawal

---

Abstract - *Content Based Image Retrieval is an important process in the field of image processing by which one can search similar images according to given query image. The most crucial factor in the CBIR systems is to identify and extract relevant feature set from an image. This paper presents a new approach for images retrieval in which color, shape and texture features are extracted. Color Auto-correlogram, color moments are used along with HSV to identify and extract color features. Texture extraction and comparison is done using Gabor filters whereas wavelet transform are used for identifying shape and orientation features. These multiple features and distance metrics are combined to obtain similarity between images using SVM. The proposed method shows encouraging results in terms of texture, color and shape classification accuracy of images.*

***Key Words*: CBIR, Wavelength Transform, SVM, Color Movement, Euclidean Distance, Manhattan Distance.**

1.INTRODUCTION

According to the cloud software company DOMOs' sixth edition of Business Cloud report, there are 2.5 quintillion bytes of data created each day at our current pace, but that pace is only accelerating with the tremendous rise in the field of the Internet of Things. In the last two years itself, 90 percent of the data in the world was generated. In this digital era, most of the data generated is in multimedia form. Some of the major sources of these huge image collections are Facebook, Twitter, Instagram, Google and many more. But the major challenge we face is in retrieval of these images as per the requirement.

In the past, the image retrieval from image databases was done using Text Based Image Retrieval (TBIR) systems. TBIR is based on keywords or description surrounding the images, that describe how the image is. These keywords are also known as 'tags' or 'metadata' associated with the image. Initially a query image is submitted and based on the keywords associated with the query image, the images from the database with similar keywords are retrieved. Google, one the famous search engines, were using the text based approach for image retrieval in earlier days. Text based approach assumes that each image has an associated tag to it. But this approach fails in case of large databases where users can upload their own files without any keywords or tags assigned to the image file. So the only solution was to manually add labels to the images. But this task of manually labeling the images with associated tags is time consuming and error prone. Another disadvantage of this method is the semantic gap between the user keywords or tags and the visual content of the image. For example, if a user submits a query "amazon", he may be looking for the picture of 'Amazon kindle' or he may be looking for 'Amazon jungle'. To overcome this semantic gap, we needed an approach which includes the visual contents of the image in the query rather than user specified tags.

Above limitations were overcome by the CBIR system. In content based method, visual contents of the image which are also known as features of the image are used for similarity matching. Features such as color, shape, texture and spatial information are extracted from the query image and are compared with the database image features. In this way we can get more accurate retrieval of images from large databases as compared to the traditional text based approach.

2. GENERIC CBIR MODEL

The term CBIR originated in 1992, when it was used by T. Kato to explain the experiments about retrieval of images based on color and shape characteristics, from large databases. Generally, this term is used to define the method of retrieving images similar to query images from a large database of image features. The techniques, various tools and methods that are used were adopted from fields of statistics, pattern recognition and machine learning.

It is the problem of searching for particular images in large databases based on their content. In this context, 'content' means the color, texture, shape or any other data that can be obtained from the image only.

A generic CBIR system has following steps:

1. ***Collection of Database:*** A database containing a number of images is required.
2. ***Query:*** Provide an image as a query.
3. ***Feature extraction:*** Various features such as color, shape, texture, etc are extracted from query image as

well as images in the database, based on the system requirement.

4. ***Similarity matching:*** It includes comparing these features to yield a result that is visually similar. Distance is used commonly as a similarity measure. There are different distances available such as Euclidean distance, City Block Distance, Canberra Distance and Manhattan distance.
5. ***Retrieval:*** The system provides a ranked and ordered images retrieved from database based on similarity measures.

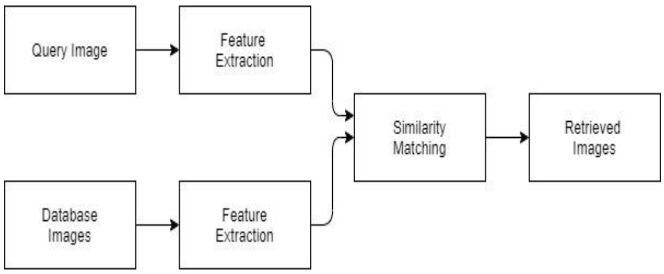

Fig -1: Generic CBIR Model

3. TYPES OF IMAGE FEATURES

Features are the facts obtained from images that is numerical values which are difficult to understand by humans. Consider the image as a set of vast information, the data extracted from this is known as feature set. Moreover, features obtained from an image are of lower dimension compared to that of the original image. Dimensional reduction decreases the burden of processing the large number of images.

There are two categories of features that can be obtained from the images namely local features and global features. Global features are mainly used in image retrieval systems, object detection systems and classification methods, whereas the local features are used for object recognition or identification scenarios. There is a vast gap between object detection and object identification. Detection is searching the existence of an object that is whether an object is present in the image or not while recognition is proving the identity of an object..

Global features define the image as a whole to generalize the entire object on the other hand the local features define the image patches. Global features consists of contour representations, shape descriptors, as well as texture features whereas local features include the texture in an image patch. Some examples of global descriptors are Shape Matrices, Invariant Moments whereas some examples of local features are SIFT, BRISK and FREAK.

For low level applications like detecting objects in an image, we use global features whereas for higher level applications like object recognition, we use local features. Combining of global and local features increases the accuracy of the recognition at the same time increasing the computational overheads.

Furthermore features are also classified into three types in image processing, that is low, middle and high. Low level features are color and texture. Middle level feature is shape. And a high level feature is the semantic gap of objects i.e. spatial information.

1.1 Color Features

The commonly found features in an image are the color features. Color is one of the intuitive feature which plays an important role in image matching. Color features are generally used widely for similarity matching because of their ease of availability and fast computations. Almost all image retrieval systems use color space, histogram, moments, color coherence vector, and dominant color descriptor to represent color. Color features are extracted using various techniques namely color histogram and color correlogram [20].

A color histogram shows the distribution of colors or intensities of an image. In case of digital images, the color histogram indicates the number of pixels that have colors according to each of a fixed set of color ranges, that cover the image's color space and the set of possible colors. Various kinds of color histograms can be built, but is generally used for three-dimensional spaces like RGB or HSV. The main limitation of histograms for classifying is the representation. It does not consider the shape and texture of the object being studied. It dependents only on the color of the object under work.

The spatial correlation of colors is represented in the color auto-correlogram, which is be used to show the global distribution of local spatial correlation of colors.

1.2 Texture Features

Texture is a feature which partitions the images into regions of similar interest and cluster them together. Texture gives Spatial information about the arrangement of colors or intensities of an image in space. Texture is obtained by analyzing the spatial distribution of levels of intensity in the surrounding neighborhood. As texture represents a repeating pattern of local variations in image intensity, it cannot be defined for a point alone.

For example, below image has a 50% black as well as 50% white distribution of pixel intensities.

Fig -2: Texture variation

These three different images having the same intensity distribution, but have different patterns of texture. Texture consists of texture elements, called as texels. Texture is often defined as fine, grained, smooth, coarse etc. Such information is present in the tone as well as structure of a texture. Tone varies with pixel intensity properties in the texel, whereas structure defines the spatial relationship between texels.

A gray level co-occurrence matrix (GLCM) contains information about the positions of pixels having similar gray level values. Texture of an image can be defined using three methods namely structural approach, statistical approach and texture segmentation. Moreover wavelength transforms are used for texture features.

1.3 Shape Features

Shape is a very powerful middle level feature. An object can be recognized from its boundaries. It can be defined as the structure of an object regardless of its position, orientation, color and size. Hence, shape features are invariant to translation, rotation as well as scale in an effective image retrieval system.

1.4 Spatial Features

Spatial data indicates the shape, size and location of the features. Spatial features would be features which exploit location or spatial information. In case of images, an example would be the dense Locally Binary Pattern (LBP) features in which an image is divided densely from a grid where for each grid box, the LBP feature is extracted. This is specially useful for face recognition in which case the location of different facial parts are to be in order.

Spatial location is also important and is used for region segmentation. Spatial location is described as top/bottom, top left or right and back or front as per the position of an object in an image. Consider an example where the sea and sky may have the same characteristics of texture and color but the spatial information is not the same. Sky typically represents the above portion and sea is at the below portion of an image. Hence, the spatial information of various objects in an image indicates important information for retrieval of images.

4. RELATED WORK

Khawaja Tehseen (2019) et. Al proposes the CBIR method using object and color signatures. Initially the image is converted into grayscale image. This grayscale image undergoes image convolution with gaussian of variance in order to remove the noise and enhance the image structure. Mexican Hat Function Approximation (MHFA) is used for detecting similar regions in the image(spatial information). Principal component analysis is used to reduce the feature vectors into a set of linearly uncorrelated variables. RGB channels are used to gain information of the color feature vectors. Bags-of-words architecture is used to represent features of image which increases the accuracy of similarity matching and forms a cluster of similar images. The system showed high precision and recall results on Caltech-101 and Corel=1000. However, the method was unable to report significant results due to the clustered background objects and overlay texture information [1].

In [2], a CBIR method is proposed which uses color features by calculating gray histograms of the images. Here, Bhattacharyya Distance is used to measure the similarity between the query image and database images. The proposed system shows fine refinement in the accuracy compared to the traditional CBIR systems.

S. Selvam (2017) et. Al proposed a more generic CBIR system using color, shape and texture features. Color moments were used as a color similarity measurement between images. Gabor filters were used for extracting texture features. Edge histogram features were used as shape descriptors. Above three descriptors were combined and optimized using genetic algorithm and HARP clustering algorithm was used for classification of images. Proposed system showed that the precision and recall parameters increased with the number of features increased (best result was obtained with color, texture, shape features together)[3].

Nikhil Chaturvedi (2014) et. Al proposed method which combines the concept of Texture based Image Retrieval system and clustering based on color component. Fuzzy clustering algorithm was used to represent color clusters of image. Each R,G,B colors had respective five subclusters namely very low, low, medium, high and very high to represent the degree of appearance for each color. Texture features namely energy, entropy and contrast were used in this method of retrieval. This system showed higher efficiency than the Texture Based CBIR and Color Based CBIR alone[4].

K. Kamala (2018) et. Al proposed a content based IR system using Gray level Co-Occurrence Matrix (GLCM) and Binary Threshold Histogram (BTH). GLCM features determined the texture of an image whereas color feature description was provided by BTH. Euclidean distance was used as a similarity measure among the features of query and database images. Also a genetic algorithm was used to reduce the feature set [5].

Yinghui Zhang (2018) et. Al proposed a CBIR system dedicated to finding similar patients with Breast cancer. Gray-Level Co- Occurrence Matrix along with histogram and correlation coefficient is used for creating the CBIR system. Texture and color features are used along with shape descriptors [7].

Priyanka Saxena (2018) et. Al proposed a CBIR system which uses a combination of color, texture and edge features. Color features are extracted using first and second order color moments. Local Binary Patterns (LBT) are used for extracting texture features. Canny Edge Detector is used for edge detection along with Gaussian Blur which reduces the image noise and speckles. The fusion of SVM along with color, texture and edge features reduces the retrieval time. Relevance feedback is used to reduce the semantic gap between the low level and high level feature [9].

Shubha .G. (2017) et. Al proposed a CBIR system for classifying satellite images with a similar query image. Initially the images are segmented into several parts using J-seg algorithm and then a region based representation is built for each image. Texture features are extracted by Gray Level Co-occurrence Matrix and used for comparison. At the end, Bayesian classifier which classifies images using a probabilistic approach is used for retrieving end results.[18].

S. S. Tadasare (2018) et. Al proposed a system which uses a hybrid feature along with various distance measures for content-based image retrieval. Color correlogram, color moments and color histograms are extracted as color features. Stationary wavelength transform, Binarized Statistical Image Features and Gabor wavelength transform are extracted as texture features. Color and Edge Directivity Descriptor which uses color and texture information into single histogram bin are used for reducing the feature sets. This experimentation was carried out with Euclidean distance, City Block Distance, Minkowski Distance, Mahalanobis Distance and Chebyshev Distance anong which Euclidean Distance showed higher precision result [13].

S. Rubini (2018) et. Al proposed a CBIR system depicting color features using color descriptors to obtain better retrieval efficiency from large databases. Initially the RGB query image is converted into grayscale image and then four morphological gradients of edge maps are generated. Seven moments of each edge map are calculated i.e. total 28 features are stored. Based on the minimum distance metrics top ten images are retrieved. Canberra Distance is used for similarity matching. [19].

5. PROPOSED METHODOLOGY

Initially, an input image known as query image is given to the CBIR system. To obtain the color auto-correlogram features, an image is converted to uint8 form which tells the spatial correlation between identical colors. 1x64 feature vector is obtained i.e. 4x4x4 in RGB space. In order to calculate the color moments of the image, the image is analyzed and 1x6 i.e. first two moments from each R, G and B channels are considered. The image to be measured in HSV color space is divided into 8x2x2 equal bins and 1x32 vector indicating the features is extracted from HSV color space.

Secondly, the input query image is converted into gray scale image. Gabor filter extracts features from this gray scale image as well as mean-squared energy and mean amplitude is calculated. Convolution are applied via Fast Fourier Transform (FFT) to enhance the image. Wavelet transform function produces 1x20 feature vector containing the first two moments of wavelet.

A low-pass butterworth filter is constructed which is used to acquire a flat frequency response over the pass-band region. It is used to filter out the frequencies above certain threshold.

Lastly, support vector machine algorithm is trained to classify the images in the database depending to the similarity score obtained between the database images and query images. The similarity score is calculated using three different distance metrics namely Manhattan distance, Euclidean distance and Standard Euclidean distance. The follow of the system is as shown.

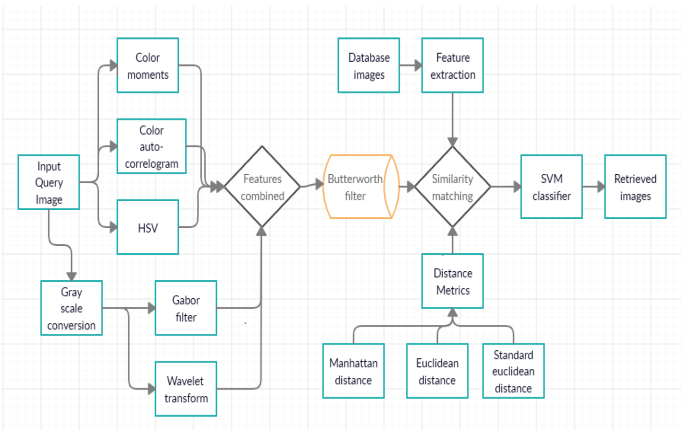

Fig -3: Proposed system of CBIR

6. EXPERIMENTATION

Corel-1000 dataset is used for testing the proposed CBIR methodology.

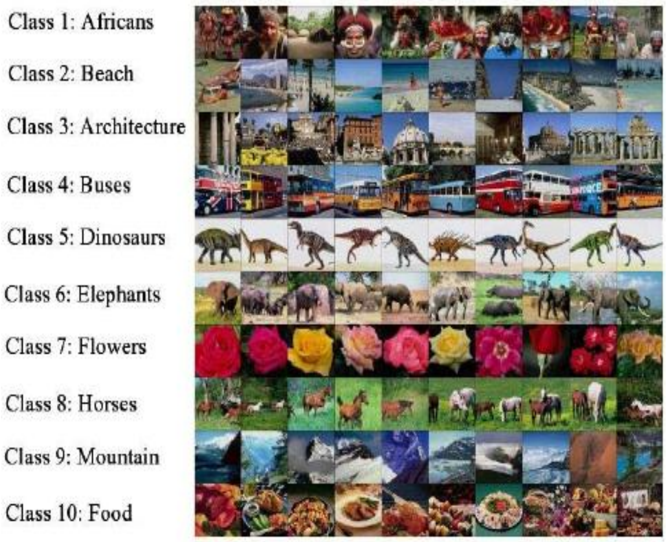

Fig -4: Corel-1000 Dataset

Query Image : Class 5 (Dinosaurs)
Number of images to retrieve : 10
Distance metrics : Euclidean distance
Output : 10 Retrieved Images

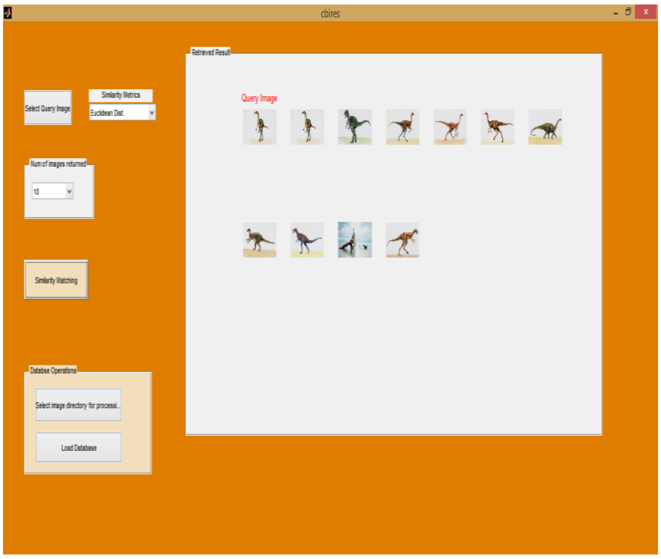

Fig -5: CBIR output

7. RESULTS

7.1 Evaluation Metrics :

Precision are the positive predicted values and are computed as :

$$PRECISION = Va / Vt$$

Where, Va = Retrieved relevant images and Vt = Total retrieved images

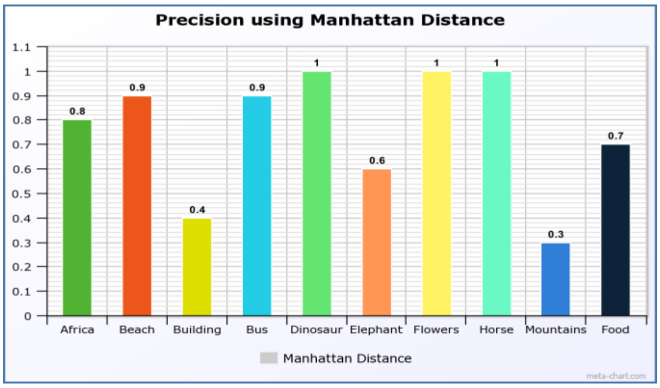

Fig -6: Precision using Manhattan Distance

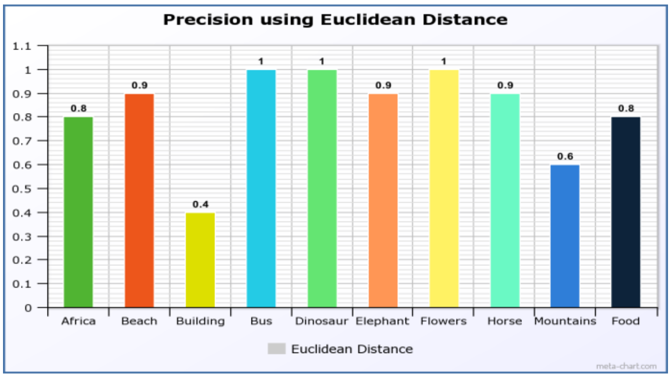

Fig -7: Precision using Euclidean Distance

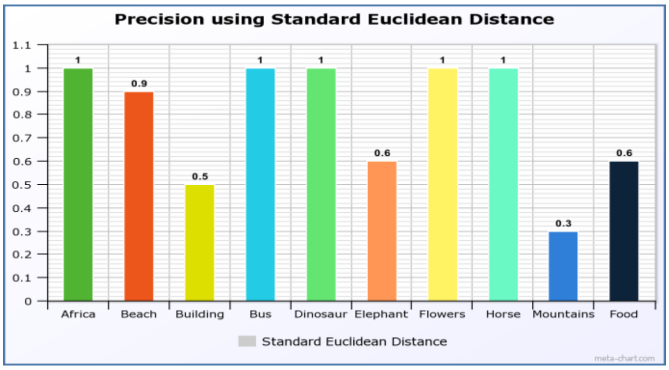

Fig -8: Precision using Standard Euclidean Distance

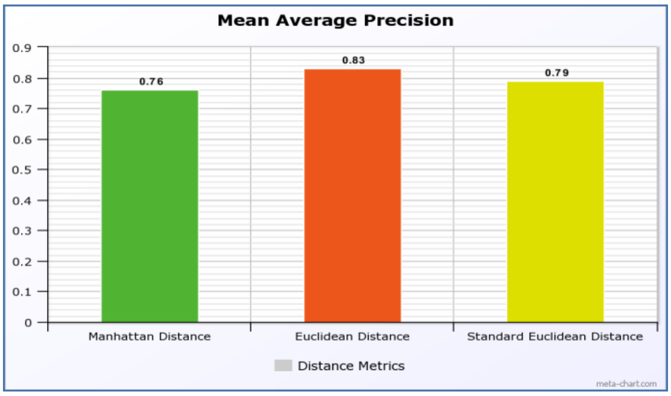

Fig -9: Mean Average Precision

8. CONCLUSION

In this paper, we proposed a better approach for image retrieval using image contents namely color, shape and texture features. The proposed new method is able to retrieve the images from various categories of benchmark dataset. The experimentation is performed on Corel-1000 dataset. The proposed new method identifies the color, shape and texture information from the complex images. Moreover the experimentation is done with three categories of distance metrics namely Manhattan. Euclidean and Standard Euclidean Distances. After calculation we can conclude that precision rate is significantly good for most of the image categories. In some categories the proposed method is unable to report best results. A future extension to this proposed method is to design a hybrid image retrieval method by combing both Text Based and Content Based Image Retrieval methodologies to retrieve better results are all categories.

REFERENCES

[1] Khawaja Tehseen Ahmed, Syed Ali Haider Naqvi, Amjad Rehman and Tanzila Saba, "Convolution, Approximation and Spatial Information Based Object and Color Signatures for Content Based Image Retrieval", ISBN 978-1-5386-8124-4 IEEE 2019.

[2] Intedhar Shakir Nasir, "A New Approach for Content Based Image Retrieval Using Statistical Metrics",Journal of Adv Research in Dynamical & Control Systems, Vol. 10, 13-Special Issue, 2018.

[3] S.Selvam and S.Thabasu Kannan , "A New Architecture for Image Retrieval Optimization with HARP Algorithm", Asian Journal of Computer Science and Technology, ISSN: 2249-0701 Vol. 6 No. 1, 2017, pp.1-5.

[4] Nikhil Chaturvedi, Saurabh Agarwal and Punit Kumar Johar, "A Novel Approach of Color-Texture based CBIR Using Fuzzy Logic", International Journal of Database Theory and Application, Vol.7, No.4 (2014), pp. 79-86.

[5] K. Kamala Kannan, Dr. G. Anandharaj, "Amalgamation of Data Mining and Image Processing Techniques in Image Retrieval", National Conference On Emerging Trends in Computing Technologies (NCETCT-18) - 2018.

[6] Minakshi Kaushik, Rahul Sharma and Ankit Vidhyarthi, "Analysis of Spatial Features in CBIR System", International Journal of Computer Applications (0975 – 8887) Volume 54– No.17, September 2012.

[7] Yinghui Zhang, Fengyuan Zhang, Yantong Cui, Ruoci Ning, "Classification of biomedical images using content based image retrieval systems", International Journal of Engineering and Management Research, ISSN: 2454-1907, Vol.5 (Iss.2): February, 2018.

[8] Rahul Mehta, Nishchol Mishra and Sanjeev Sharma, "Color - Texture based Image Retrieval System", International Journal of Computer Applications (0975 – 8887) Volume 24– No.5, June 2011.

[9] Priyanka Saxena, Shefali, "Content based image retrieval system by fusion of color, texture and edge features with svm classifier and relevance feedback", International Journal of Research Granthaalayah, ISSN- 2350-0530(O), ISSN- 2394-3629(P) Vol.6 (Iss.9): September 2018.

[10] Deepu Rani, Assistant Professor Monika Goyal ,"Content Based Image Retrieval System Using Improved SVM Technique", International Journal of Advanced Research in Computer Science and Software Engineering, ISSN: 2277 128X, Volume 4, Issue 10, October 2014.

[11] Yogita Mistry, D. T. Ingole and M. D. Ingole, "Content Based Image Retrieval using hybrid features and various distance metrics ", Journal of Electrical Systems and Information Technology 5 (2018) 874-888.

[12] Prof. Suresh M B and Dr. B Mohankumar Naik, " Content Based Image Retrieval Using Texture Structure Histogram and Texture Features", International Journal of Computational Intelligence Research, ISSN 0973-1873 Volume 13, Number 9 (2017), pp. 2237-2245.

[13] S. S. Tadasare, Prof. S. S. Pawar, "Content Based Retinal Image Retrieval Using Lifting Wavelet Transform for Classification of Retinal Fundus Images", International Journal of Electrical Electronics & Computer Science Engineering Volume 5, Issue 1 (February, 2018) | E-ISSN : 2348-2273 | P-ISSN : 2454-1222.

[14] P. Shamna, V. K. Govindhan and K. A. Abdul Nazeer, "Content-based medical image retrieval by spatial matching of visual words'', Journal of King Saud University - Computer and Information Sciences (2018).

[15] V. Ramya, "Content Based Image Retrieval System using Clustering with Combined Patterns ", International Journal of Scientific Research in Computer Science, Engineering and Information Technology, IJSRCSEIT, ISSN : 2456-3307 Volume 3, Issue 1, 2018.

[16] G. Sucharitha, Ranjan K. Senapati, "Local quantized edge binary patterns for colour texture image retrieval ", Journal of Theoretical and Applied Information Technology, Vol.96. No 2, 31st January 2018.

[17] Gaber A. Sharawy, Neveen I. Ghali, Wafaa A. Ghoneim , "Object-Based Image Retrieval System Based On Rough Set Theory ", IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.1, January 2009.

[18] Shubha .G. Sanu, Pushpa .S. Tamase, "Satellite Image Mining using Content Based Image Retrieval", IJESC Volume 7 Issue No.7, 2017.

[19] S. Rubini, R. Divya, G. Divyalakshmi and Mr T. M. Senthil Ganesan, "Content Based Image Retrieval (CBIR)", International Research Journal of Engineering and Technology (IRJET), Vol 5, Issue 3, Mar-2018.

[20] Ms Pragati Ashok Deole, Prof. Rushi Londadge, "Content based image retrieval using color feature extraction with KNN classification", International Journal of Computer Science and Mobile Computing, ISSN 2320-088X, Vol 3, Issue 5 May 2014.

BIOGRAPHIES

Sayli Dinesh Zope has completed her Bachelor of Engineering in computer Engineering from Pune Institute of Computer Technology, SavitriBai Phule Pune University, Pune. She is currently pursuing her Masters in Technology in Computer Science and Engineering from Shri Sant Gadge Baba College of engineering, Dr Babasaheb Ambedkar Technological University, Lonere.

Dr Dinesh D. Patil is working as associate Professor and Head of Department of Computer Science and Engineering with 13 years of experience at Shri Sant Gadge Baba College of Engineering, Bhusawal. He has completed his PhD from University of Technologies and Medical Sciences, Sehore in February 2020