An Approach of K-means Clustering Based SVM ensemble for Image Retrieval

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Abstract - *Content Based Image Retrieval is important for retrieving the visual relevant image from the huge database. Color, Texture, Shape information has been primitive image descriptors in CBIR. In Content-Based Image Retrieval System, the visual feature (Color, Texture, and Shape) are represented at a low level. In this paper, we have extracted the feature of technique with using K-means clustering and use the SVM classifier.*

Key Words: Content Based Image Retrieval, Feature Extraction Technique, Color, Texture, and Shape, K-means clustering, SVM.

1. INTRODUCTION

With the improvement of digital image and videos, CBIR has become an important research area to search and retrieval useful information. Content-Based Image Retrieval is the process of the retrieving the image of the huge database and using the extraction feature methods [1]. CBIR includes the digital image, video, audio, graphics and the text data. We have many ways to retrieve an image. Feature Extraction is one function of CBIR its mean mapping the image pixels into the feature spaces. Image retrieval is a technique which is concerned with searching & browsing digital image from the huge database. Image database uses in many fields like as medicine, biometric security, satellite image processing, military, and security purpose.

2. CONTENT BASED IMAGE RETRIEVAL (CBIR)

The term Content-Based Image Retrieval (CBIR) was originated in 1992. It was used by T. Kato to describe experiments into automatic retrieval of an image from a database, based on Color & Shape present [2]. Content-Based Image Retrieval is an application of the computer vision and it is used to retrieve the image in the huge database. "Content-based" means searching of the contents of an image rather than the metadata like as keywords, tag, or characterization related with the image. Content-Based Image Retrieval represent in the form of figure 1. Content-Based Image Retrieval is defining the two type categorized.

(a) Text Query:

Image is defining the form of the **Text such** as keywords and caption. Text features effectively as a query if suitable text descriptions are given for descriptions in an image database.

(b) Pictorial query:

An example of an adopted image is used as a query. To restore related image like an image feature such as color, a texture is used [3].

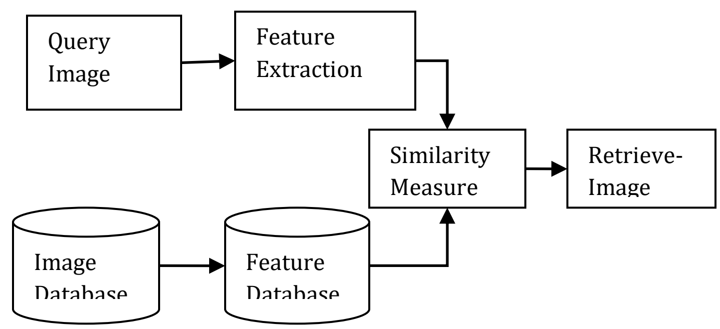

Fig -1: Architecture of Content Based Image Retrieval

3. LITERATURE REVIEW

In 2015, Suresh MB, Dr. Mohan Kumar Naik; Proposed color space feature texture method for image retrievals, such as RGB HSV and YCbCr. Texture feature is extracted by applying GLCM [4].

In 2017, Miss Dhanshree S. Kalel, Miss Pooja M. Pisal, Mr. Ramda P. Bagawade; Proposed the three visual feature Color , Texture, Shape to retrieve query image from large database color shape and texture extracted feature for given query image and measure the similarity from database image and retrieve the similar image as a query image extraction features [5].

In 2016, Ms. V. Ausha, Ms. V. Usha Reddy, Dr. T. Ramashri; Proposed an algorithm to retrieve the color image from the database using color moments and the texture of a color image. The color moments integrates the mean, standard deviation, and the skewness. The texture explanation is calculated using the energy and entropy [6].

In 2014,Divya Srivastava, Rajesh Wadhavani, and Mausi Gyanchandani; a proposed different feature of extraction and design comparative study for selection of these methods of various applications [7].

In 2015, Neelima Bagri, Punit Kumar Johari; Proposed combination texture and shape feature in which for texture they have used GLCM + Hu-moment, they have used Tamura + Hu-moment for shape [8].

In 2013, Manish Maheshwari, Dr. Mahesh Motwani, Dr. Sanjay Silakari; A new color quantization ordering scheme that focuses on color as feature and considers Hue-Value and Saturation (HVS) space. Image pixel color is quantized and histogram of these both 54 colors is calculated. The clusters of images k-means algorithm is applied [9].

4. FEATURE EXTARCTION

Feature extraction is the process of automatically computing a compressed representation of some characteristic of the digital image, to be used to derive information about the image contents. The feature includes the two type of feature. One is **Text Based Feature** (Keywords, Annotations) other one is **Visual Feature** (Color, Texture, Shape, and Region). Visual feature extraction is the basis of any CBIR technique. Visual features further divide the two type feature. One is Low-Level Feature another is High-Level Feature [10].

4.1 Color Features

"Color is a way to attract the human eyes". Color is an important feature of the feature extraction. Color feature is a specific feature part of CBIR. It is an important part of the human visual perception mechanism [11]. Color feature defines the two groups of the color. One is color histogram another is statistical methods of color. Color features are generally used for image representation because of their simplicity and effectiveness. Color points are creating color space. Color space based on the perceptual concepts is used for color illustration. It is the most important feature of the image. The most popular and generally used low-level descriptor in image CBIR system is the color feature. The color of an image is represented by some color model. There exist different color model to define the color information. A color model is described in terms of a 3-D coordinate system [12]. In the color features, color models play a vital role.

4.1.1 Color Moment

Color moments are used to differentiate images based on their features of color. A color moment is a statistical moment of the probability distribution of the color. It is used to measure the color correlation between images [13]. I suffer from the problem that they fail to encode any of the spatial information surrounding the color within the image. They have 3 parameters are calculated in this method [14] [15].

Moment 1: Mean: - The first color moment is the mean; it can be average color in the image. It can be calculated by [16]:

$$E_i = \sum_{N}^{j=1} \frac{1}{N} P_{ij} \quad (1)$$

Moment 2: Standard Variance: - The second color moment is the standard deviation. It is taking the square root of the variance of the color distribution [16].

$$\sigma_i = \sqrt{\left(\frac{1}{N}\sum_{N}^{j=1}\left(P_{ij} - E_i\right)^2\right)} \quad (2)$$

Moment 3: Skewness: - The third color moment is Skewness. It measures of the degree of in the distribution [16].

$$s_i = \sqrt[3]{\left(\frac{1}{N}\sum_{N}^{j=1}\left(P_{ij} - E_i\right)^3\right)} \quad (3)$$

4.2 Texture Feature

The texture is the most important property of all surfaces that describes visual patterns, each having properties of homogeneity texture is mostly used in content-based image retrieval [17]. It provides the information about the structural arrangement of the surface i.e. clouds, leaves, fabric etc. It is a fast and efficient texture feature extraction method for content-based image retrieval system in an embedded system [1]. Textures are represented by Texel which is then placed into a number of sets. These set not only define the texture but also where in the image the texture is located. It is usually used to point to particular properties of surfaces especially those that do not have a smoothly varying intensity. Texture feature provides the collection of an image. The most commonly used second-order statistics method is Gray- Level Co-Occurrence Matrix (GLCM).

4.2.1 Gray-level co-occurrence matrix (GLCM)

Gray- level co-occurrence matrix is one of the best well-known texture analysis methods. The Gray- level co-occurrence matrix is well defined statistical method for extracting the second order texture information from the image. Gray-level-co-occurrence matrix is a part of the texture features extraction method. Gray- level co-occurrence matrix and associated texture feature calculation are image analysis technique. Texture feature process uses the collections of the GLCM to give a measure of the variation in intensity at the pixel of concern. Gray-level co-occurrence matrix Texture operator that creates a virtual variable which represents a specified texture calculates on a single bulk of image [4]. Haralick, Shanmugan, and Dinstein recommended fourteen measures of textual features and they each correspond to certain image properties such as energy, contrast, correlation, homogeneity. Some of them which are commonly used are [18].

Energy: - Energy is the sum of squared elements in the GLCM; the energy is given by [19]:

$$\text{Energy(E)} = \sum_{i,j}(i,j)^2 \quad (4)$$

Contrast: - It measures the local variations in the gray-level co-occurrence matrix. The contrast is given by [19]:

$$\text{Contrast (c)} = \sum_{i,j}(i-j)^2\, p_{(i,j)} \quad (5)$$

Correlation: - The joint probability occurrence of the specified pixel pairs. The correlation is given by [19]:

$$\text{Correlation(c)} = \sum_{i,j}\frac{(i-\mu_i)(j-\mu_j)p_{(i,j)}}{\delta_i\delta_j} \quad (6)$$

Homogeneity: - The level of the distribution of elements in the GLCM to the GLCM diagonal. Homogeneity is given by [20]:

$$\text{Homogeneity} = \sum_i\sum_j\frac{p(i,j)}{1+|i-j|} \quad (7)$$

4.3 Shape Feature Extraction

The shape of item performs a fundamental role among the different aspects of visual information. Shape feature extraction is a dominant feature when used in similarity measure and retrieval image. If a shape is used as a feature, edge detection might be the first step to extract that feature. In our work, the canny edge detector is used to complete the edge of the object in the display. After the edge has been detected the important step is tracing the contour of the item in the display. For this, the edge image is examined from four directions (right to left, left to right, top to bottom, bottom to top) and the first layer of the edge occurred is detected as image contour. To avoid discontinuation in item boundary the contour image is then re-sampled. After the item contour has been detected the first step in shape representation for an item is to locate the center point of the item. It contains all the geometrical information of an object in the image. Shape feature include are perimeter, area, eccentricity, symmetry, etc. Shape feature representation is divided into two parts such as Boundary-based and Region-based. Boundary-based need only the outer boundary of the shape whiles the Region-based need the entire shape region [21] [22].

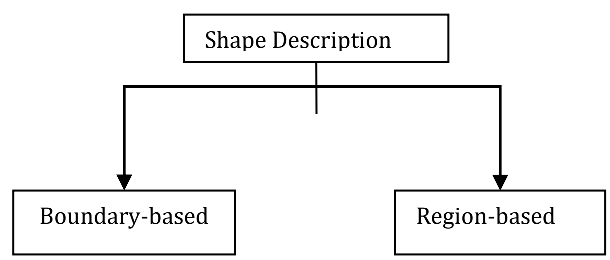

Fig -2: Classification of Shape Feature

4.3.1 Edge Histogram Descriptor

The Edge Histogram Descriptor is mostly used scheme for shape feature extraction. Shape feature is extracted by the edge histogram descriptor. Local concentration change along an appropriate orientation, i.e. called an Edge. Edge are classified into five types of position such as vertical, horizontal, 45^0 diagonal, 135^0 diagonal and non-directional edge [23]. We are analysis this feature one form of the use histogram. We are describing this feature use of the Edge Histogram Descriptor (EHD) in shape feature extraction. If we want to get the information approximately the local classification of edges over the perfect image in form of the histogram, a process is available known is Edge Histogram Descriptor (EHD). We have calculated the 80-bin local histogram the essential image is allocated into 4×4 equal-sized non-overlapping section. A local histogram is calculated for exclusive of this sub-image for each one edge type [24] [25].

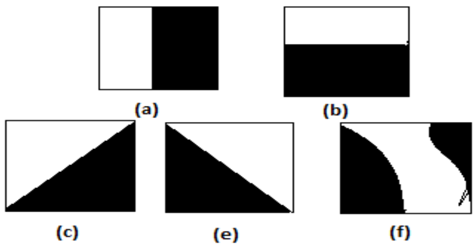

Fig -3: (a) Vertical (b) Horizontal (c) 45-degree (d) 135-degree and (e) Non-directional

4.3.2 Sobel Edge Detection

Sobel edge detector needs the masks as shown in the figure below totally approximate the first order derivatives Gx and Gy.

$$G = [G^2{}_x + G^2{}_y]^{\frac{1}{2}} =$$

$$\{[(z_7 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7)]^2 + [(z_3 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7)]^2 \}^{1/2} \quad (8)$$

In the important usage, the grayscale image use as an input, as is the output. It represents 2-D structural grade analysis on an image. Sobel edge detection provides a pair of 3x3 convolution mask. The spatial gradient of input image at every point is denoted by the estimated absolute output magnitude pixel value at those points.

Z1	z2	z3
Z4	z5	z6
Z7	z8	z9

(a)

-1	-2	1
0	0	0
1	2	1

(b)

-1	0	1
-2	0	2
-1	0	1

(c)

(a) Image neighborhood

(b) $G_{x=} \quad (z_7 + z_8 + z_9) - (z_1 + z_2 + z_3)$ (9)

(c) Sobel mask

$G_{y=} \quad (z_3 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7$ (10)

4.3.3 Canny Edge Detector

It is important for using edge detector. This technique defines the distributed noise of image by an edge. It does not interest the feature of the edges of the image. This method describes the edges using canny edge detector is as follows steps.

Step1: The image is smooth using the Gaussian filter to reduce noise.

Step2: The local gradient G(x,y)=$[G^2{}_x + G^2{}_y]^{\frac{1}{2}}$ and edge direction $\alpha(x,y) = \tan^{-1}(\frac{Gy}{Gx})$ are estimated at each points. This method is used for any of the Prewitt, Sobel, Roberts technique can be estimated as Gx and Gy. An edge point is a point whose strength is locally maxi-mum in the direction of the gradient.

Step3: The edge point detected in step 2 give rises to ridges in the gradient magnitude image. The algorithm after trailing the top of elevation, all the pixels which are not on the top set to zero so as to generate thin line as output, a system which is called a non-maximal suppression. The elevation pixels are then threshold using two thresholds, T1 and T2, with T1<T2. Ridge pixels with values greater than T2 are said to be strong edge pixels. Ridge pixels with values between T1 and T2 are said to be weak edge pixels.

Step4: In the last step the algorithm performs edge linking by incorporating the weak pixels that are 8-connected to the strong pixels [24].

5. PROPOSED METHODOLOGY

5.1 K-means Clustering

K-means clustering is an unsupervised learning [26]. The intention of this algorithm is to search the cluster in data, along the number of clusters is performed by the variable K. K-means or Hard c-means clustering is a separation method are enforced to analyses the data as objects occupy the location and distance between distinct inputs data points. If we want to separate the object to the mutually exclusive clusters (k), there is a process available as a fashion that objects within each cluster remain as close as possible to each other but as far as possible from objects in other clusters. Every cluster describes all center points i.e. centroid. We cannot say this distance called a spatial distance when using the between the clustering. There is a huge problem of global minimum and there is only one solution is the comprehensive choice of starting points. We can handle this problem by use of various repeated with casual starting points leads to solutions i.e. global solution. In a dataset, the desired number of clusters k and a set of k initial starting points, the K-means clustering algorithm search the crave number of different groups and their Centroids. By calculating the ordinary of each of the coordinates of the points of illustrations transfer to groups, we can achieve the coordinates of the centroid [27].

Algorithmic steps for K-Means clustering

Step 1: K - Determine a number of distinct clusters, K

Step 2: Initialization – Determine k starting points which are used as initial estimates of the cluster centroid. They are taken as the initial starting values.

Step 3: Classification - To examine each point in the dataset and assign it to the cluster whose centroid is nearest to it. This can be done by computing the Euclidean distance between the points.

Step 4: Centroid Calculation - When each point in the dataset is assigned to a cluster, it is want to recalculate the new k centroids.

Step 5: Convergence Criteria – The step of 3 and 4 require to be repeated until no pints changes its cluster assignment or until the centroids no longer move.

Finally, this algorithm aims at minimizing an objective function, in this case, a square error function. The objective function:-

5.2 Support Vector Machine

SVM was prospective by the Vapnik and is obtaining popular in the field of machine learning. This is an efficient classification for purpose of pattern recognition. It is used in real-world problems such as voice recognition, text categorization, image classification, object detection, handwritten digital recognition, and data classification. For higher execution in the classification of the image such a machine SVM because it takes a better result compares the other data classification algorithms [23]. Support Vector Machine is a supervised learning technique. If someone wants to consider the data and discover the classified pattern which is used when such a machine is required that is Support Vector Machine (SVM) [24]. If there is need to classify the data into distinct classes with the help of hyper-planes such a machine is required know as SVM i.e. classifier, which give minimum classification error and maximum margin [29] [30].

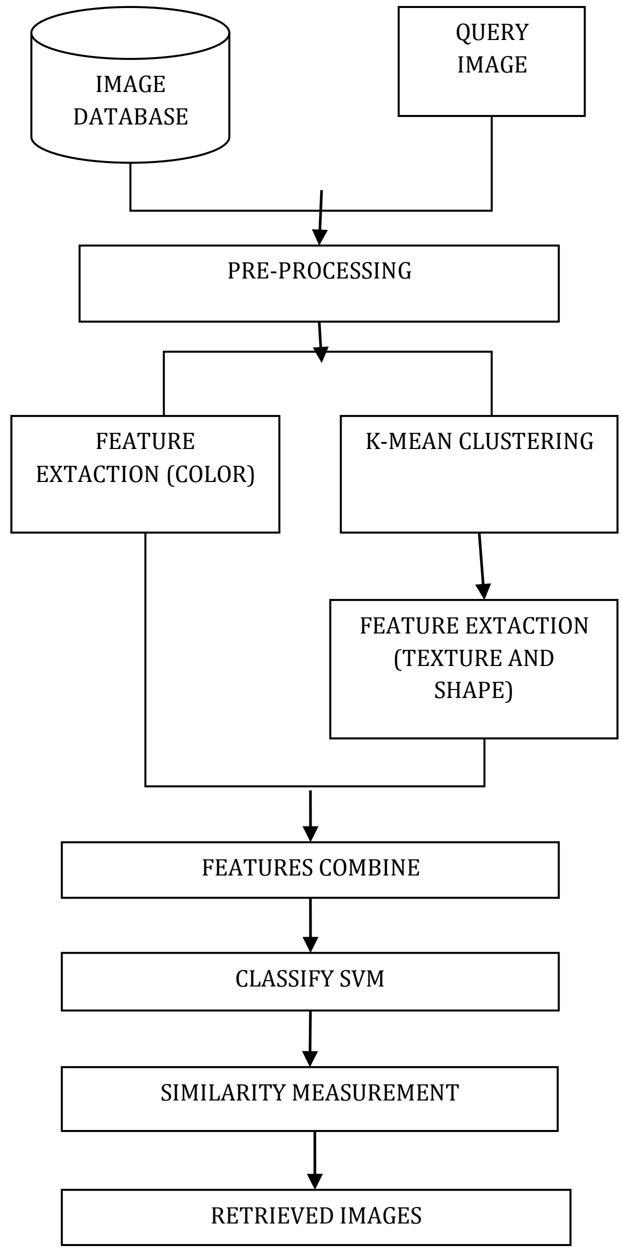

Fig -4: Flowchart of Proposed Methodology

5.3 PROPOSED ALGORITHM

1. Input image the query image.

2. Pre-processing on the image. Firstly resize the image with 384*256 image size. After that, convert RGB image to process image and then enhance the contrast of test image using contrast adjustment.

3. Apply the k-mean for clustering and gives a segmented image

4. Apply the feature extraction technique using color, texture, and shape.

5. Feature Vector = [Color moment]

Feature Vector = [GLCM]

Feature Vector = [Edge Histogram Descriptor]

6. Apply the Similarity Measurement algorithm L1, L2, Correlation, Hamming. Relative Deviation and Jaccard distance.

7. Retrieve the final image based in the similarity measures from images stored in database.

6. EXPERIMENTAL RESULT

6.1 Similarity Measurement

a) Manhattan distance: Manhattan distance (L1) where the Euclidean geometry is replaced by a new metric in which the distance between two points [31] [32]

$$L1 = \sum_{i=1}^{n} |T_i - D_i| \quad (12)$$

b) Euclidean distance: Euclidean distance matrix is very used for the similarity measurement substance retrieval image from the database because it's found the higher accuracy and effectiveness. It finds the distance between the two feature vectors of the images. Euclidean distance is computing the square root of the sum of the squared complete differences [9] [31] [32].

Compute the L2 distance. Given two vectors *T* and D, where

$$d(T, D) = \sum_m \sum_n d_{mn}(T, D) \quad (13)$$

c) Correlation distance: Correlation distance is used to measure of statistical dependence between two random variables or two random vectors of arbitrary [31] [32].

$$Corr = \frac{Cov(T,D)}{\sqrt{Var(T)Var(D)}} \quad (14)$$

d) Jaccard distance: Jaccard distance for distinction or comparison between two vectors [31] [32].

$$d^{JAS}(i, j) = \frac{J_{11}}{J_{01}+J_{10}+J_{11}} \quad (15)$$

In the equation d^{JAD} is the Jaccard distance between the objects *i* and *j*. For two data records with *n* binary variables *y* the variable index *k* ranges from 0 to *n*-1. Four different combinations between $y_{i,k}$ and $y_{j,k}$ can be different when comparing binary variables. These combinations are (0/0), (0/1), (1/0) and (1/1). The sums of these combinations can be grouped by:

- J_{01}: the total number of variables being 0 in y_i and 1 in y_j.
- J_{10}: the total number of variables being 1 in y_i and 0 in y_j.
- J_{11}: the total number of variables being 1 in both y_i and y_j.
- J_{00}: the total number of variables being 0 in both y_i and y_j.

As each paired variable belongs to one of these groups it can be easily seen that [31] [32].

$J_{00} + J_{01} + J_{10} + J_{11} = n$, As the Jaccard similarity is based on joint presence, J_{00} is discarded.

e) Relative Standard Deviation: Relative Standard Deviation (RSD) flanked by them is given by [31] [32].

$$RSD = \sqrt{\sum_{i=1}^{n} (T_i - D_i)^2} \quad (16)$$

6.2 Experiment Database

In proposed system, we performed on the following datasets, Corel-1k and Corel-1600 is used. Corel-1k dataset, every category consist 100 images of size 384*256 in all format. The database is divided into 16 classes: African, Beach, Monument, Elephant, Horse, Building, Food, Flower, Mountain, Dinosaur, Bus, Painting, Mushroom, Sky, Dogs, and Models.

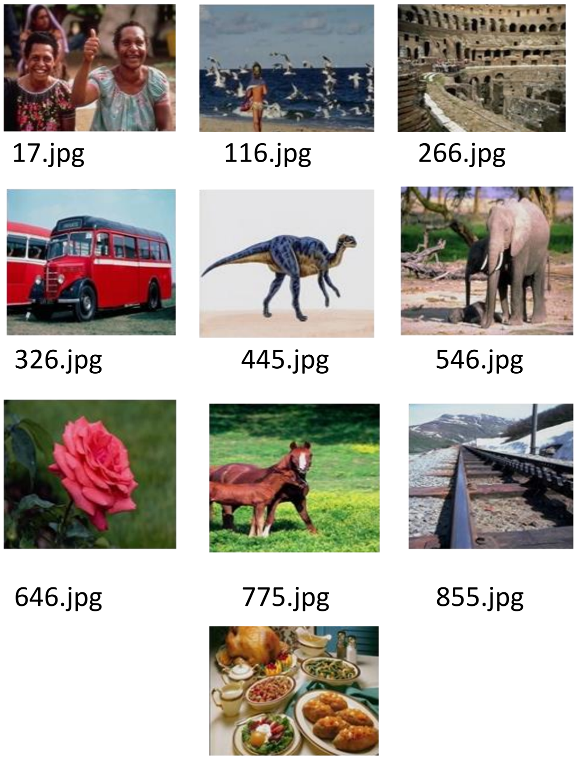

Fig -5: Image Dataset

6.3 Results

In this paper, we are using L1, L2, Correlation, Jaccard distance, Relative Standard Deviation distances for similarity measures. In this proposed the number of matched images in fluctuating from 1 to 20. Here show the example of CBIR on Corel dataset by proposed algorithm. Calculated average precision and average recall for whole class.

Fig -6: Enhanced Image

Fig -7: Result on Dog Category

Fig -8: Result on Food Category

Fig -9: Result on Dinosour Category

Table -1: PRECISION COMPARISON BETWEEN BASE AND PROPOSED APPROACH

Category	Base Precision (%)	Proposed Precision (%)
African	76.74	96.89
Beach	88.37	97.11
Monument	87.17	96.67
Bus	79.48	97.78
Dinosaur	85	98.22
Elephant	81.63	97.56
Flower	80.85	97.33
Horse	82	97.56
Mountain	84.09	97.78
Food	81.81	96.89
Average	82.71	97.38

Table -2: ACCURACY COMPARISON BETWEEN BASE AND PROPOSED APPROACH

Category	Base Accuracy (%)	Proposed Accuracy (%)
African	83	96.62
Beach	82	96.87
Monument	83	96.625
Bus	83.6	96.5
Dinosaur	82.4	96.125
Elephant	81	96.5
Flower	84	96.25
Horse	82.6	96.375
Mountain	81	96.25
Food	81.8	96.62
Model	80.62	96.62
Dogs	80.37	96.75
Sky	80.87	96.75
Mushroom	80	96.62
Historical Buildings	82.87	96.5
Paintings	80.5	96.5

Table -3: RECALL COMPARISON BETWEEN BASE AND PROPOSED APPROACH

Category	Base Recall (%)	Proposed Recall (%)
African	66	95.75
Beach	76	96.06
Monument	68	94.37
Bus	62	94.8
Dinosaur	68	94.45
Elephant	80	94.43
Flower	72	95.8
Horse	82	95.62
Mountain	74	96.06
Food	72	95.83
Average	72	95.41

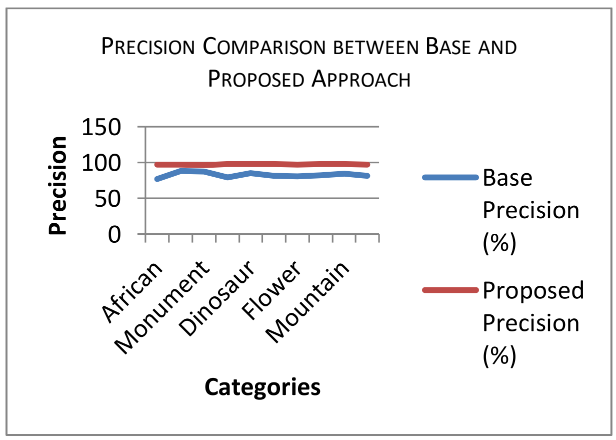

Fig-10: PRECISION COMPARISON BETWEEN BASE AND PROPOSED APPROACH

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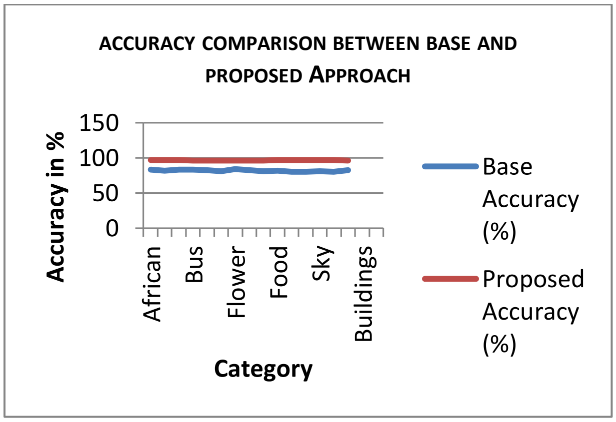

Fig-11: ACCURACY COMPARISON BETWEEN BASE AND PROPOSED APPROACH

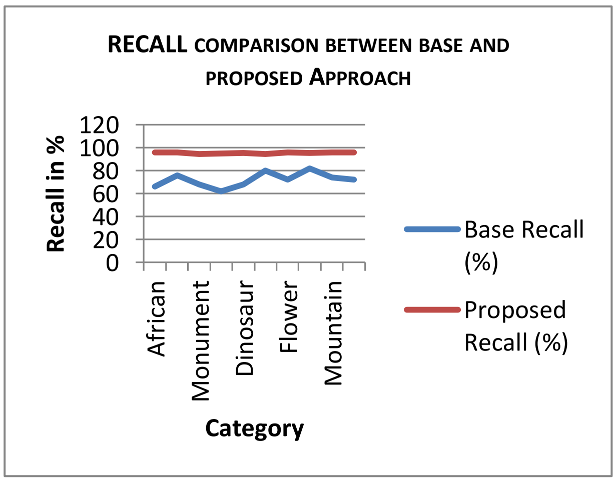

Fig-12: RECALL COMPARISON BETWEEN BASE AND PROPOSED APPROACH

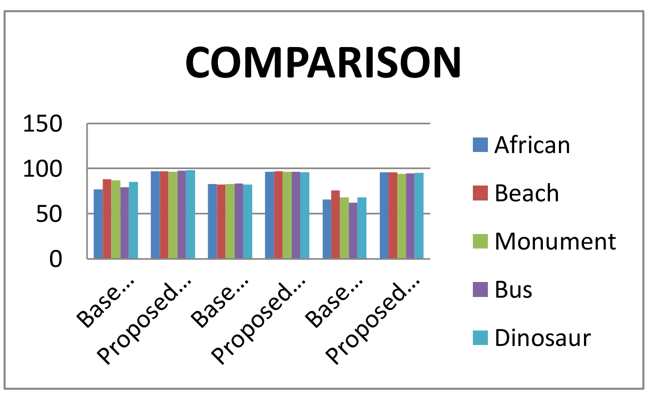

Fig-13: COMPARISON BETWEEN BASE AND PROPOSED APPROACH

7. CONCLUSION

In this paper, CBIR is performed extraction on the huge image datasets. It retrieved images on the basis of image descriptors. We used Color moment, GLCM and Edge descriptor. Color feature use for better color performance and Edge detection is used for object edges and those features are uses for give me a better results precision and recall.

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