International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Content Based Image Retrieval Using Shape, Color and Texture

Nallakkagari Phani Kumar

Abstract: ***The increased need of content based image retrieval technique can be found in a number of different domains such as data mining, education, medical imaging, crime prevention, weather forecasting, remote sensing and management of earth resources. Here, we present the content based image retrieval, using features like texture, shape and color, using wavelets termed as WBCHIR (Wavelet Based Color Histogram Image Retrieval). The results are found to be satisfactory with retrieval efficiency of 85 % and recall of 76.2%. the feature set used has 72 feature values derived from 4 scale & 6 orientation with mean, standard deviation and energy measures. With increase in image based searching and also increase in volume of image database information on web has been substantially exploited based on visual clues. An effective and computationally efficient algorithm has been topic of internet amongst researches. In this work an image database with more than 1000 images and having at least 10 categories is used and tested with WBCHIR method.***

Keywords: CBIR, WBCHIR, Categories, Color Histogram, Scale, Orientation, Algorithms, Color, Shape, Texture, Gabor Filters

1. Introduction

The main theme for selecting this project is mainly to follow up the present state of art in retrieving the images which are based on the content present in it. In the following technique we use retrieval of images which are mainly based on automatically-deriving the attributes or features such as color, shape and texture of the input image. In this process we are mainly base our findings on both the review of the approximate literature and on some discussions with researchers in the related field.

The most important thing here is mainly to find the desired pictures from a pool of pictures which is mainly shared by many professional groups, including journalists, historians and some design engineers. The main need is to make image search user adaptive that can be classified into three main features namely primitive or primary features such as color or shape of the image, and then the logical features of the image such as to identify the objects which possess abstract attributes that have significance to the scenes and are of user interest. While the retrievability based on content systems are mainly working enormously only at the initial levels, but so many users are demanding for the higher levels to retrieve the images.

2. Motivational Factors

Societal Factors:

It is assumed to be true, if we look into the images which are currently used in all parts of life. The influence of graphical video games and TV in the modern society is almost clear for everyone to observe. The most common primary reason for storing, transmitting and displaying the pictures is most probably for amateur use, although all these categories which includes a very wide variety of distinct attitudes and the interactive styles, in hope to improve each one's own game. For example a tennis player is watching the latest sequence of matches to improve his shots by analysing each and every frame. In recent times the use of pictures are substantially increasing to deliver the message (information), such as non similarity map making, shopping through the mail order and in the areas of forecasting and future weather conditions, and mainly it is to exhort or to convey a mood which is done in advertising. They can also be comprehended in their own right, as works of art. A fully explained sociological study on image use would be carried out of place in this report, at that instance there is a small proof for the existence of distinct user communities with different needs. So many individuals are directly dealing with the images in different ways at distinct times, perhaps by dealing an hour in art exhibition gallery, and by watching a sports video. This application type does not seem very useful, if we are trying to categorize such behaviour.

Industrial Factors:

If we observe in the area of professional use of pictures and in the area of the technical side, the situation is completely different which is unknown. But there are many distinct usage of styles among the personal engineers in designing, now by considering an example, that the nature of the design process that requires a maximum number of unavoidable attributes within that possibilities the engineers has to work. Hence it is admissible to extrapolate to some deal about the way the images are being used by distinct professions. But by fixing to our topic, in the report we have prepared and we are mainly concentrating on the image storage and the precision of the picture retrievability, and hence it makes us to give some sense to thresolding our aim or the part of discussion to fix us to the uses which mainly stresses on the collection of the stored pictures in particular or some other ways. On some things that we are doing in regular basis, some of the groups of people who uses pictures in their jobs, likely as a graphic designers and their illustrations, while some other working people or the professional people may never be like, it is mandatory to utilise images, for the people who used to work in the banking sectors. And we can say that there are so many large numbers of employees, professions that are lying among these two categories or extremes. In the above said professions one can include the medical department and the law department. Apart from these we have some other committees such as the librarians who used the image retrievability technique which is used to find the particular book specifications and availability. The

other group employees which includes the museum curators to get the status of the available monuments in the museum. These people are in need to find the pictures on taking the advantage of the visitors rather than for their use. And it is highly impossible for an employee to provide the whole picture here for the usages which are mainly available for the visual data purpose.

Crime Prevention:

In recent times if we observe in the field of crime investigation, the cops are using the visual information in identifying the convicts or to store the scenes of crime for future evidences over a period of time. This stored database is valuable evidence to retrieve at the needed hour. In western countries it is the most common practice to take the picture of each and every individual who were arrested and collecting their finger prints. The photographs of the accused will be tagged with the main record for the concerned person. In a computer-based system, the photographs of the accused are to be digitized and linked to the related textual records. Later if the accused is to be proved as acquitted, the file which has the images, fingerprints and the data of the accused are deleted. If the accused is proved to be convicted, then the file of that convict is send to the National Fingerprint Bureau. In law enforcement we use images which include face recognition, surveillance systems, shoe individual impressions, and DNA matching. The city Metropolitan Police Force in London is working with a project which is setting up an international database of the images of stolen objects.

Representing an Image in MATLAB

Each and every image when we are dealing in Matlab is to be stored in the form of matrix which uses the patterns which follows the standard and generalised Matlab matrix representations. Normally, Matlab software supports five different types of images:

1. Intensity images
2. 8-bit images
3. Binary images
4. Indexed images
5. RGB images

Matlab always handles the image data in the form of matrices. The process involves the partitioning of each and every pixel of an image into some disciplines of a matrix. Matlab will differentiate the coloured images and the gray scaled images and therefore the output of the image matrices will vary accordingly. Normally we can say that a color is a combination of some primary pigments (red, green and blue). MATLAB therefore breaks each and every pixel of coloured image down into three different basic component primary colour (RGB) values. The outputs of the picture values are to be stored in 3 matrices for the entire image data, and then each matrix in the data represents each color. All the three matrices which we get as output for the image are to be built or stacked next to each other by just creating a matrix size of m x n x 3. To understand properly an image is shown below, by looking at the image below we can observe that the image is having height of 5 pixels and the image having a width of 10 pixels and the output will be a matrix of 5 x 10 x 3 for the given image.

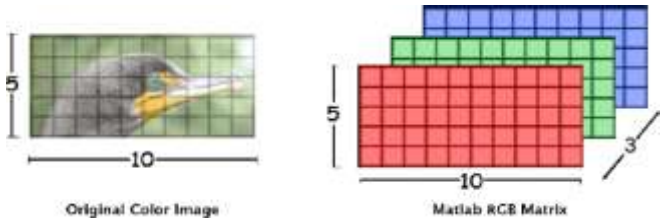

Figure 1: (a) Representing the color image (b) RGB matrix

And now we will discuss about the gray scale which is a combination of two different colours (namely black and white). Among these colours, some of the colours may be called as the 'shades', shades doesn't comprises of Red, Green or Blue colours. They have different levels of colours that allocates between the range of black and white. Hence, to represent this entire range, we need only one color channel. Hence, we only used a normal 2-D (two dimensional) matrix, m x n x 1.

Now consider the same example which we used, an image having height of 5 pixels and the image having a width of 10 pixels and the output will be a matrix of 5 x 10 x 1 for the gray scale image.

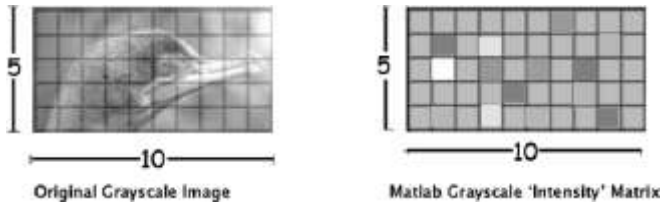

Figure 2: Gray scale image representations

3. System Design

Content Based Image Retrieval System

The pictures are playing a prominent role in the present technology trends like in medicine for detecting the internal tumours and the fractures, education field such as for e-class rooms and in journalism for the related articles with pictures and in advertising etc., and we can say that the technology is mainly improvised in the fields of inventions such as photography and television, which play a prominent role in the modern world. These inventions made easier to the world for storing the data and as well as communication of the data in the form of images.

Apart from these, the main revolution came when the computer was invented fascilitating many digital image processing techniques and processing the data. It is also used for storing the data and for transmitting the data purpose. The invention of computers transmissions have been startled the initiators like John Logie Baird.

The direct involvement in the area of imaging by the computers is dated back to the year 0f 1965, which explains the availability of computerised creation by Ivan

Sutherland's Sketchpad Project. The project mainly explains the manipulating the data and storing the data which are in the form of images.

Because of heavy budget required for the installation of hardware they limited their usage until the time of mid 1980's. Once the computer games came into the real world the computerised imaging pricing became cheap because of creating a mass market for video games. After that it gets changes drastically in the areas of engineering, medicine and architectures which are heavily depends on images for the communication. The technology later establishes its requirement in the fields of art galleries and photograph libraries etc., afterwards the big change came in the starting of 90's by introducing the www, which enables the users to get access to the data which they needed from anywhere in the planet which provides more importance for the development of digital pictures.

An example that clearly explains the image retrieval technique can be seen in considering police forces. At present they are using the automatic face recognition systems. These type of systems are used in either of the ways. In the initial way the person or convict who is standing in front of the camera, his or her image is allowed to compare with the individuals in database record to verify their identity which is stored apriori. In the lateral way the person who is standing in front of the camera, his/ her image is allowed to examine through the entire database of the police records to find the most matching image picture.

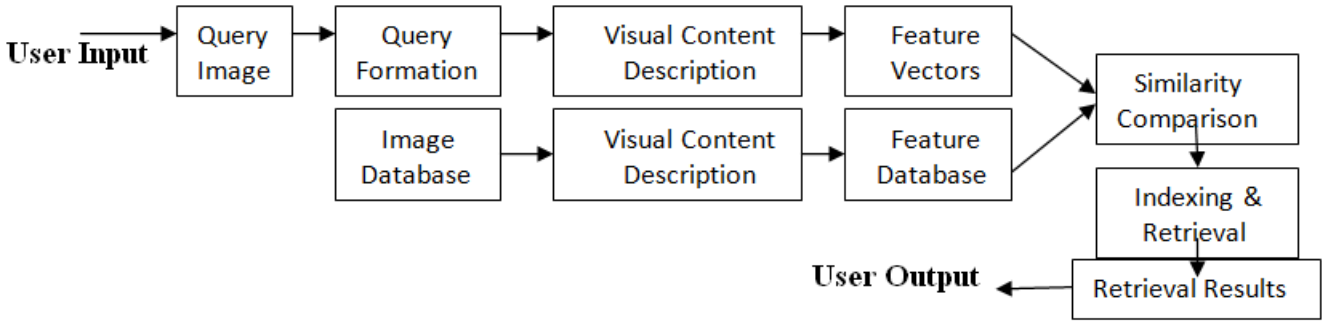

Figure 3: Block Diagram of Content Based Image Retrieval (CBIR)

Image Retrieval Based Upon Content

Image Retrieval based upon the content is an application which is mainly used for retrieving those similar images from a huge set of picture databases which mainly uses the image attributes such as the color, texture, shape and some other attributes.

Color Feature

Several techniques are prevailing that are used for image retrieval based upon the color similarity which are explained in the literature, but differ mainly upon the basic color discrimination. Every image in the database is analysed to perform the color histogram that displays the maximum picture elements of each primary color present in the image. Further the histogram of each and every image in database is stored. While the user performs the search from the search engine the user is to be allowed by giving input as the needed proportion color by just submitting the exemplar image for which the system has to calculate the histogram.

The most prominently working technique used in this type of retrieval is the histogram intersection; this technique was first implemented by a scientist named "Swain and Ballard" in 1991[5]. The changes that we have done on this technique are used in the current system presented in this work.

The techniques that we are using here to improve the Swain and Ballard's technique are by using the cumulative color histograms and then we are following a method of combining the histogram intersection with respect to some other element of the spatial matching, we are also using some other technique where we mainly performing the segmentation, by doing region based color querying. And the outputs that are obtained from these systems are very much satisfactory.

Space Selection and Quantization

The color of a given input image is represented by using some of the color spaces that are available to us namely RGB, HSV, YUV etc., and the experiments shows that the HSV model gives us the best color histogram attributes when compared to the other color spaces. The usage of HSV color space in our image retrieval project is explained clearly by the scientist Surel et al[2]. If we are using the HSV color space, we have to note that the color is explained in terms of Hue, Saturation and the values where hue gives us the data in the form of angle, saturation gives us the primary color existence and the value represents the brightness in the image. HSV color space is mainly represented on the cylindrical co-ordinates.

Color Histogram

It represents the composition of colours in the input image by using some sets of bins, where each and every histogram bin will have a color in the quantized color space. The general representation for the color histogram of an image is given by

N= {N [0], N [1], N [2], N [3], … …… … N[a]… N [n] }. ---------->(1)

Here a = Color bin in the color histogram
N[a] =Count of pixels which belongs to the color a in the image,
n = It gives the bins count which we used in the histogram

Generally, each and every picture element in a given input image will be assigned to a bin of a color histogram. Hence as a result, the color histogram of an input image, the value that is present in each and every bin will gives the count of picture elements that has the same sample color. For comparing the images of different sizes, we have to normalize the color histogram bins. The equation for the normalized color histogram N' is

N'= {N' [0], N' [1], N' [2], N' [3]..... N' [i]..... N' [n] }----------> (2)

Texture Feature

The next technique that we use is to retrieve the images based upon the texture feature, but this feature is not very helpful in retrieving the images. Despite this limitation we are using the texture feature which will be helpful in the situation of discriminating between the areas of the images which exhibit similar color. The other techniques that we are using here is an established technique that rely on comparing the values what we called as the second order statistics which will be measured from the input query image and also for every image stored in the database. This technique measures the corresponding luminance of the surrounding pixels from each and every image. By these, it is easier to find the measures of texture such as the contrast of the image, directionality of the image periodicity etc.,.

The other technique that we used in the texture analysis is the use of Gabor filters. In this technique the texture features we extract from the image is exactly the same that we did in extracting the color features by just providing the input image or by giving the desired texture description values from the palette.

The system which we built will find the similarity between the query image features with respect to the images in database and will show the thumbnails of the related images that exhibit similarity to query image.

Gabor wavelet equation in spatial domain is given by

$$X(u_1, u_2) = \exp\left(-\frac{(u'^2_1 + \gamma^2 u'^2_2)}{2\sigma^2}\right)\exp\left(i\left(\frac{2\pi}{l}u'_1 + a\right)\right)$$ ----------> (3)

$u'_1 = u_1\cos\theta + u_2\sin\theta$, ----------> (4)

$u'_2 = u_2\cos\theta - u_1\sin\theta$. ----------> (5)

In the above equation, l represents the wavelength of the sinusoidal factor,
θ represents the orientation of the normal to the parallel stripes of a Gabor function,
a is the phase offset, σ is the sigma/standard deviation of the Gaussian envelope and
γ is spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function.'

u_1, u_2 are the co-ordinates which specify the pixel value of image

Here we are taking 3-6 scales (4 for higher accuracy) and 6 orientations. (0, 60, 120, 180, 240, 300).

Haar Discrete Wavelet Transforms

Discrete wavelet transform performs transformation of a given image from the spatial domain to the frequency domain. It constitutes a function which acts as the superposition of a group of basic primary functions which we called as the wavelets. The main function of these transforms is to extract the data from the input at different levels by allowing the signal through the basic filters. These wavelets give the varied resolution availability and give some high energy exaltation. These wavelets are compact w.r.t the intensity variations and these can be used to store both the shape and texture data efficiently. The transforms of the wavelets are to be found linearly with respect to the time and by then it permits for very fast algorithms performance.

Generally the DWT segregates the given input signal into two functions namely the basis and the wavelets. The calculation that we followed to find 2-D image using wavelet transformation is also a different, where we are going to apply or using the sub sampling technique and the recursive filtering. The image is allowed to pass through the four frequency bands which are shown in below figure, where L & H denotes the low and high frequencies respectively.

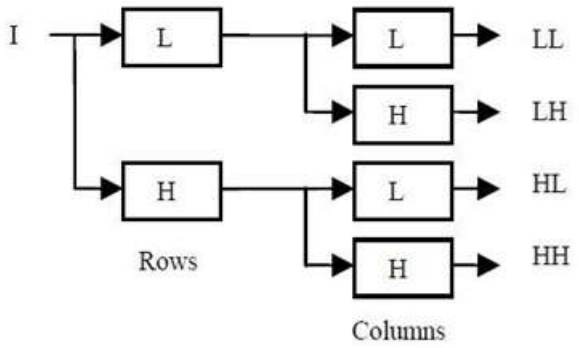

Figure 4: Discrete Wavelet Sub-band Decomposition

Haar Wavelet's mother wavelet function Ψ(a) can be described as

$$\Psi(a) = \begin{cases} 1 \; 0 \le a \le \frac{1}{2} \\ -1 \; \frac{1}{2} \le a \le 1 \\ 0 \; otherwise \end{cases}$$ ----------> (6)

Its scaling function is given by

$$\Psi(a) = \begin{cases} 1 \; 0 \le a \le 1 \\ 0 \; otherwise \end{cases}$$ ----------> (7)

In this work we are using Haar wavelet transforms to find the attributes or feature signatures. Haar wavelets are found very useful in many domains after it was proposed by Haar.

Haar wavelets have been found to be actuate well in the general practice. These findings help us to increase the retrievability phase when we are dealing with almost thousands of overlaid windows whose sizes are non linear in an image. Apart from these we are using Gabor wavelets in order to achieve higher accuracy even if the image is taken as input in some other angle according to our scaling and orientations.

Feature Similarity Matching

The definition for the above heading is given by the process of rounding off the solution to the nearest attributes. It is mainly to be used on finding the closeness function among the pair of images, and then the resultant is always a set of same values. However, the precision is a known concept amongst researches. In our work we are using so many distance functions for finding the similarity between the query and database images.

4. Proposed CBIR Algorithms

Here we mainly propose two different algorithms that are used for the image retrievability based on the histogram charts or values, the first method is to be named as the Colour Histogram which uses color as the basic feature, and the second method uses the Wavelet transforms which we named as the wavelet based color Histogram. The algorithms and the flow charts for the proposed ones are showed below.

Algorithm for Color Histogram

Step 1: Convert the given coloured image from RGB space to HSV space.
Step 2: Then quantization is to be carried out on the given coloured image using the histogram process by using hue, saturation and values to 8x2x2 by giving this we will have a quantized HSV space with 8x2x2=32 histogram bins.
Step 3: After performing quantization we are performing the normalisation operation on histogram bins
Step 4: Post normalisation, we will repeat the process from step 1 to step3 on each and every image that are available in the database.
Step 5: Find the matrix which is similar to the query image features and the image features that matches the image in the database.
Step 6: Repeat all the steps from step4 to step5 for each and every image that are present in the given image database.
Step 7: In the final step retrieve all the relevant images from the database which are similar to the query image.

Algorithm for Wavelet-Based Color Histogram (WBCH).

Step1: Extract the primary color components from the given input image
Step2: After extraction disintegrate each primary color component using the haar wavelet transformation and gabor wavelet transformation at first level to get the coefficients of nearby vertical, horizontal and the diagonal details of the input image
Step3: After fetching details combine all the coefficients to the nearby red, green and blue components
Step4: In this step, repeat step 3 to combine the horizontal and vertical coefficients of all the primitive color components.
Step5: In this step assign the weights 0.03 for approximating the coefficients and 0.001 to all the horizontal and 0.01 to all the vertical components which were observed experimentally
Step6: After assigning the weights the horizontal and vertical coefficients convert the wanted or the required, coefficients of horizontal and vertical values into HSV plane values.
Step7: In this step the quantization is to be carried out on the given coloured image by using the histogram process by using hue, saturation and values to 8x2x2 by giving this we will have a quantized HSV space with 8x2x2=32 histogram bins.
Step8: Here we are performing the normalisation operation on histogram bins.
Step9: Repeat horizontal and vertical values into HSV plane values. the steps from step1 to step8 the given image which is present in the database.
Step10: In this step find the matrix which is similar to the query image features and the image features that matches the image in the database.
Step11: Repeat the steps from step 9 to step10 for each and every image that is present in the database.
Step12: In the final step retrieve the images from the given image database.

Performance Measures and Evaluation

The effective working of the system that is built measured in terms of the accuracy and recall. Recall is mainly responsible to measure how exactly the retrieved system is recollecting all the images that belong to their respected classes, while on the other hand the precision will calculate the performance of the designed system which we build in recollecting the images that are likely belong to the query image class. From the numerous experiments it is said that the usage of histogram will give the best and the highest performance measure through by using the recall and precision values. The formulae for the precision or accuracy and recall is given below

$$\text{Accuracy} = \frac{\text{Total relevant images retrieved that belong to query class}}{\text{Total retrieved images count}}$$

$$= \frac{P}{P+J} \text{ ----------> (8)}$$

$$\text{Recall} = \frac{\text{Total relevant images retrieved that belongs to query class}}{\text{Total retrieved images count of same class}}$$

$$= \frac{P}{P+S} \text{ ----------> (9)}$$

Here,
P= The total number of the relevant images that are retrieved belongs to query class
J = The total number of the irrelevant images that are retrieved
S = The total number of the relevant images that are not retrieved
The number of suitable items that are retrieved represents the number of returned pictures which are

likely to that of the query input image in the above mentioned case.

The accuracy mean for the pictures that belongs to the n^{th} category (P_n) has been calculated by

$$\mathbf{m' = \sum_{a \in P_n} \frac{m(j_a)}{|P_n|}} \text{ ----------> } \mathbf{(10)}$$

Where n=1, 2,3,……,9,10.

Ultimately, the average precision is given by:

$$\mathbf{m' = \sum_{n=1}^{10} m'_n \, / \, 10} \text{ ----------> } \mathbf{(11)}$$

5. Experiments and Results

The proposed technique has been tested using Matlab 9.3 version R2017a and is tested on a prevalent-purpose storage (database) which has one thousand pictures or images, which are in PNG or JPG form of size in dimensions of 256x384 as well as 384x256 pixels.

The resolution is generally based upon the similarity or likeliness instead of the accurately matching. So, here we have affirmed the image retrieval technique, on using some distinct quantization schemes.

The calibre of the process of image retrievality, by using distinct quantization schemes shown below has been calculated by taking around some randomly selected input query images, of each and every category, that were selected from the folder of the database of images stored.

After submitting the query image, each and every query image will display the top most one to twenty (according to our selection) images that are present in the image stored database, then we are computing the accuracy or precision values by using the equation (8) and by taking the average of the accuracies using the equation (11) which is given in Table 8.1.

By observing the values we got in table 8.1, we can say that the average accuracy we got 8.4/10 value that we got for the (8, 2, 2) quantization bins gives us the much better retrieved results when compared to the others.

Table 1: Precision Using Different Quantization Schemes

Category	4,4,4	4,4,8	4,8,8	8,2,2	8,4,4	8,8,4	8,8,8	18,3,3
Monuments	9	9	9	10	9	9	9	10
Dinosaurs	6	5	5	7	4	6	6	3
Clocks	6	6	6	7	6	7	6	8
Flowers	9	9	9	10	9	9	9	9
Beach	8	10	9	8	7	8	9	8
Food	7	8	8	8	7	8	9	7
Horses	6	6	6	10	7	7	7	7
Buses	9	9	9	9	10	9	9	10
Elephants	6	6	6	6	5	5	6	6
Mountains	8	7	9	9	8	8	8	8
Average precision	7.4	7.5	7.6	8.4	7.2	7.6	7.8	7.6

The other histogram retrievability technique which we used in this work is the wavelet based color histogram (WBCH), as explained in the previous section. It is mainly utilized for deep learning in image retrieval by usage of (8, 2, 2) color quantization cradles and fulfilment of the appropriate image retrievability techniques The calibre of the process of image retrievability, by using distinct quantization schemes shown below has been calculated by taking around some randomly selected input query images, of different category, selected from the available database of images. After submitting the query image each and every query image will displays the top most one to twenty (according to our selection) images that are present in the image stored database, and then we are computing the accuracy or precision values by using the equation (8) and by taking the average of the accuracies using the equation (11) which is given in the below Table 8.2.

From here we observed that the output for the ten query image retrievals by the given method, which is having a mean retrieval time of 5 seconds. After computation the outputs are clearly shown that the achievement of the expedient method is better than the other methods. The overall precision by the system is 83 ± 2%.

Table 2: Accuracy of Retrieval using different method

Classes	Category	WBCH	CH	CT by Lin	CT by Raghu	CTSby PSH	CTD/CIRS
1	Monuments	0.65	0.72	0.68	0.75	0.54	0.562
2	Dinosaurs	0.62	0.53	0.54	0.6	0.38	0.536
3	Clocks	0.71	0.61	0.56	0.43	0.30	0.61
4	Flowers	0.92	0.93	0.89	0.69	0.64	0.893
5	Beach	0.97	0.95	0.99	1	0.96	0.984
6	Food	0.86	0.84	0.66	0.72	0.62	0.578
7	Horses	0.76	0.66	0.89	0.93	0.68	0.899
8	Buses	0.87	0.89	0.8	0.91	0.75	0.78
9	Elephants	0.49	0.47	0.52	0.36	0.45	0.512
10	Mountains	0.77	0.82	0.73	0.65	0.53	0.694
	Average Precision	0.762	0.742	0.726	0.704	0.585	0.7048

Results of the project (CBIR) application are shown in the form of figures below

Figure 5: Retrieved Outputs

Figure 6: Confusion Matrix

Plotting the confusion matrix gives us the performance accuracy of the supporting vector machine which we have defined inside the project. By taking the mean of the diagonal percentage values we will find the precision of the system.

6. Conclusion and Future Scope

In the thesis, we find a strange ingress to the CBIR by taking the average of color, shape and texture appearances called the Wavelet based Color Histogram Image Retrieval. The important thing here we can observe is that the likeliness between the pictures by using so many distinct functions. Finally, the output that we observed shows this technique gives the best results when compared to the former retrieval techniques in terms of the mean accuracy.

Besides, the calculational steps are efficiently decreased with the use of Wavelet. And we can also observe that the indexing time for entire thousand images which we used in the database takes only around 8-9 minutes.

Exploiting the abundant functioning future scope quantifies we will surely calibrated the abundant appearances and potentially provide the exploiters with better choices of retrieval as the default arguments, A great deal like the Google search by picture, is the appearances, unification alternatives and distinct standards ideally concealed but adjust aside the search outputs will be as pertinent as conceivable to the enquiry. From hereafter the work we are preparing is evaluating the function abundant options, and put up three dimensional (3D) visualisation of the searched results.

References

[1] Y. Chen and J. Z. Wang, "A Region-Based Fuzzy Feature Matching Approach to Content Based Image Retrieval", IEEE Transactions on Pattern Analysis and Machine Intelligence. Vol. 24, No.9, pp. 1252-1267, 2002.
[2] A. M. Smeulders, M. Worring and S. Santini, A. Gupta and R. Jain, "Content Based Image Retrieval at the End of the Early Years", IEEE Transactions on Pattern Analysis and Machine Intelligence, 22(12): pp. 1349-1380, 2000.
[3] S. Manimala and K. Hemachandran, "Performance analysis of Color Spaces in Image Retrieval", Assam University Journal of science & Technology, Vol. 7 Number II 94-104, 2011.
[4] J. Wang, G. Wiederhold, O. Firschein and S. We, "Content-based Image Indexing and Searching Using Daubechies' Wavelets", International Journal on Digital Libraries (IJODL) 1, (4). pp. 311–328, 1998.
[5] J. R. Smith and S.F. Chang, "Visual SEEk: a fully automated content-based image query system", ACM Multimedia, 1996.
[6] C. Carson, S. Belongie, H. Greenspan and J. Malik, "Blobworld: image segmentation using expectation-maximization and its application to image querying", IEEE Trans. Pattern Anal. Mach. Intell. 8 (8), pp. 1026–1038, 2002.
[7] S. Li and M. C. Lee, "Rotation and Scale Invariant Color Image Retrieval Using Fuzzy Clustering", Published in Computer Science Journal, university of Hong Kong, 2004.
[8] Y. Rui, T. S. Huang and S.F. Chang, "Image Retrieval: Current Techniques, Promising Directions and Open Issues. Journal of Visual Communication and Image Representation. 10(4): pp. 39-62. 1999.
[9] T. Kato, "Database architecture for content-based image retrieval", In Proceedings of the SPIE – The International Society for Optical Engineering, vol.1662, pp.112-113, 1992.
[10] Y. Liu, D. Zang, G. Lu and W. Y. Ma, "A survey of content-based image retrieval with high-level semantics", Pattern Recognition, Vol-40, pp-262-282, 2007.
[11] H. Lin, c. Chiu, s. Yang. "Finding textures by textual descriptions, visual examples, and relevance feedbacks". Pattern recognition letters, vol. 24, no. 14, pp. 2255–2267, Jan 03.
[12] M. Banerjee, M. K. Kundu and P. K. Das, "Image Retrieval with Visually Prominent Features using Fuzzy set theoretic Evaluation", ICVGIP, 2004.
[13] J. M. Fuertes, M. Lucena, N. P. D. L Blanca and J. C. Martinez, "A Scheme of Color Image Retrieval from Databases", Pattern Recog. Vol. 22, No. 3, pp- 323-337, 2001.
[14] M. Stricker and A. Dimai, "Color indexing with weak spatial constraints", IS&T/SPIE Conf. On Storage and Retrieval for Image and Video Databases IV, Vol. 2670, pp.29-40, 1996.
[15] J. Eakins and M. Graham, "Content-Based Image Retrieval", Technical report, JISC Technology Applications Programme, 1999