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A Review from Basic Image Features to Their Integration in Content Based Image Retrieval System

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Abstract-From last few years, the need of massive database used to store vast images has been developed rapidly and will also grow in the future. From the enormous database, extracting and querying of the images in a proper manner is important to produce the visual content. Content Based Image Retrieval System (CBIRS) provides us utmost outcome to fetch the images from massive dataset. In these systems, different features like texture, shape, color, spatial information, edge etc. can be used to represent an image. This paper provides the review of basic features of an image denoted by color, texture and shape. For color feature extraction, techniques like color histogram (CH), dominant color descriptor (DCD), Color correlogram etc. have been described. Tamura, steerable pyramid, Gabor wavelet transform, grey level co-occurrence matrix (GLCM) are the techniques described for texture features extraction and lastly Zernike moments and MPEG-7 for shape feature extraction. If we are using single feature to retrieve the image, it takes more retrieval time. In this paper, a review of fusion based retrieval system is described. The paper also discusses the fusion of features in which more than one feature is used and the results of individual features (color and texture) are fused to extract the images from large database. By using the fusion approach, better results can be produced with the higher precision value.

Keywords-Content Based Image Retrieval System (CBIRS), Grey Level Co-occurrence Matrix (GLCM), Dominant Color Descriptor (DCD), Zernike moments (ZMs).

I. INTRODUCTION

In today's life, there is a major role of images in various fields like, military application, medical field, digital camera, art collection, fingerprint identification and historical research etc. which generates the need of a large volume for the data storage and image extraction automatically [4]. To search an exact image or set of images in the large dataset is a very complicated task without using any search algorithm. There are two approaches to retrieve the images from large datasets namely,

1) Text Based Image Retrieval System (TBIRS)
2) Content Based Image Retrieval System (CBIRS)

TBIRS refers to the traditional method for image retrieval. In this method, images are searched by the text annotations but this method has many limitations like time consumption, misspellings so by using TBIR query image should use exact keywordsotherwisemismatch of images will occur. To overcome the all limitations of TBIRS, CBIRS was introduced.

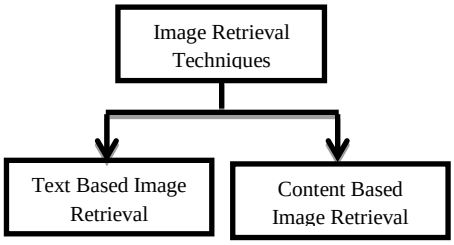

Fig.1. Image Retrieval Techniques [25]

CBIR is considered to be persuasive and is the best way to retrieve the images. CBIRS is a low level system [6]. The fig.2 shows block diagram of basic CBIRS. The process of retrieving a particular image starts by giving an input image called as query image to the system. First query image is represented as features vector and the conversion technique used for this representation is the same as that was used in image database block. The images are sorted as per resemblance value and the resultant image is acquired from the CBIRS [9]. Colors are described in different color models but prominent models are **RGB** (Red, Green and Blue), **YCbCr (**representing Luminance and two Chrominance components),**HSV (**Hue, Saturation and Value) and many more [11].

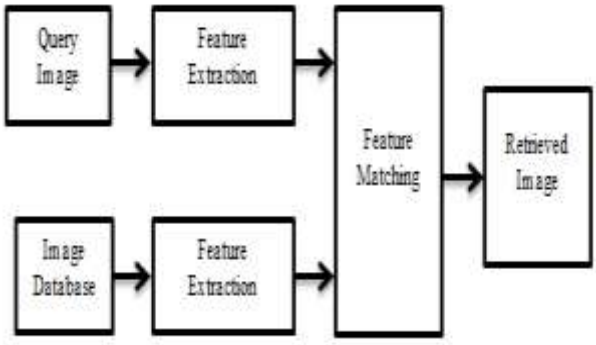

Fig. 2 Block diagram of basic CBIRS [26]

Another two important feature used to distinguish the image is Texture and shape. Visual system of human is used for texture recognition and interpretation [11]. The organization of this paper is as follows: Section I describes introduction. In section II, feature extraction techniques related to various image features are discussed. Fusion of color, texture and shape features is discussed in section III. Distance metrics for Similarity calculation are discussed in section IV. Section V describes the related work and applications are discussed in section VI.

II. FEATURE EXTRACTION

Feature fetching is a backend operation applied for image database. In this section color, texture and shape techniques used in CBIR are explained.

Color Feature Extraction Techniques: The significance of this feature is that its extraction as well as matching is simple. Indexing and searching is also effective. The motive of color feature extraction is to extract all images of database whose color composition is almost identical to the query image [13].

A. Color Histogram: Color histogram is a technique which is used to express the color information. This is widely used method because of its easy implementation, non-sensitive and rapid nature. Rotation, translation and scaling of an image can be changed but histogram of an image cannot be changed [8] [21]. In this method, three color channels namely R, G, B are considered and intensity calculation of their independent probabilities is taken out. Histogram is obtained by computing every color pixels exist in the image and all color pixels are carried in separate bins. This method can be given by:

$$h_{X,Y,Z}(x,y,z)=N.Prob(X=x,Y=y,Z=z) \quad (1)$$

Where *N* is represents the no. of pixels in the image and *X*, *Y* and *Z* represent three color channels [8].

B. Color Correlogram: A color correlogram provides the information regarding how the colors pairs are changed with distance. The characteristics of color correlogram can be explained as: (i) defines correlation of colors in spatial plane, (ii) implemented to evaluate the overall distribution by local spatial correlation of colors, (iii) computation complexity is less and (iv) its dimensions are small evenly [8].

C. Color Co-occurrence Matrix (CCM): CCM is a general method that is used to obtain variations in color of the image, where between pixels of same color and their respective neighbors, calculation of probability of occurrence is made. [8] [14].

D. Dominant Color Descriptor (DCD): DCD accommodates only one component, named as representative color and is based on the clustered mean value. In this technique, first RGB (Red, Green and Blue) color image is partitioned in 10 parts which are to be represented into quantized colors and quantized colors are calculated by taking centroid point for each partition (color bin). RGB are the color components and represent the color of a pixel $I_{pixel} = (\bar{R}, \bar{G}, \bar{B})$.
By using the formula center value of each partition can be calculated [4];

$$\text{Cluster\_ Center} = \frac{\sum_{i=1}^{N} I(x,y)}{\sum_{i=1}^{N} 1} \quad (2)$$

I(x, y) represent the pixel value present in original. N denotes the totality of picture elements available in specific cluster. After that, 10 quantized color details are controlled by the equation which is given below [4]:

$$\text{Dominant\_ Color} = \bar{R}, \bar{G}, \bar{B} \text{ , } (1 <= i <= 10) \quad (3)$$

Here i represent the total count of cluster center.

Texture Extraction Techniques

Texture is an additional useful characterization of an image feature which is used for interpretation and recognition by human visual system. [11].

A. Tamura Texture Feature: Tamura features are based on the human visual recognition. Fundamentally there are six tamura texture features and they are contrast, coarseness, line likeness, directionality, regularity and roughness. These features are used in psychological studies by considering human perception of texture [8].

B. Steerable Pyramid: This technique recursively partitions an image into a low pass residual and a set of oriented sub-bands. Decimated low pass sub bands and set of decimated oriented sub bands are obtained by dividing the original image. It is a useful technique which has many advantages as compared to

other methods like multi-orientation, multi scale image perishing. Kth- order directional derivative operator is a major function of this technique which is found in many sizes and has orientation of K+1 [11].

C. Gabor Wavelet Transform: This transform is used to dilate and rotate the two dimensional Gabor function. Gabor function is basically established by sampling all frequency domains and by finding all parameters of orientation and particularly its center frequency. In this method, both Gabor filter and Gabor wavelets of a particular spatial frequency can be applied to an image. This function denoted by g(x, y) can be expressed by equation[11]:

$$g(x, y) = \frac{1}{2\pi\sigma_x\sigma_y} \exp\left[-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right) + 2\pi j W_x\right] \quad (4)$$

Here center frequency is given by W,$\sigma_x$and $\sigma_y$are scaling factors of the filter.

D. Gray Level Co-occurrence Matrix (GLCM): Here spatial relationship between the pixel values of the image is given by this technique. This relationship covers four diverse directions between pixels and also degradation between them. GLCM architecture made up by two phases: 1) Preprocessing phase and 2) Feature extraction phase. Phase 1 operates over input data and phase 2 proceed two tasks first is extraction of the features and second combination of both hardware and software to calculate GLCM features [3]. GLCM architecture is represented below:

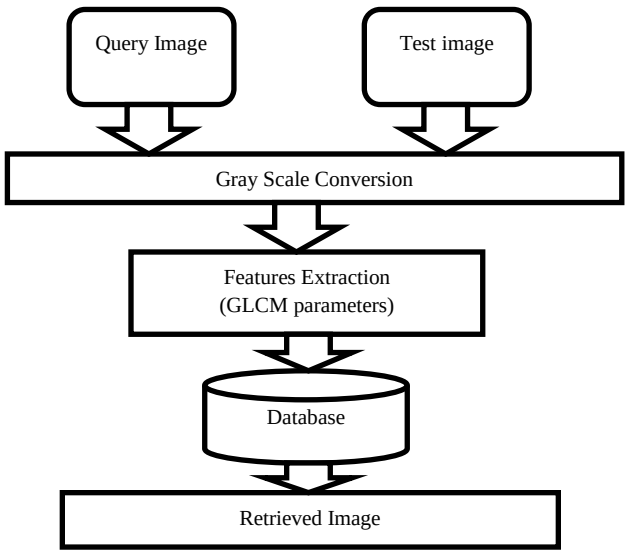

Fig.3 Architecture of GLCM [3]

In this technique, color image is transformed as grayscale image and image co-occurrence matrix is determined. The equations representing GLCM properties are expressed as [3]:

$$\text{Mean} = \sum_i \sum_j P(i,j) * i \quad (5)$$

$$\text{Variance} = \sum_i \sum_j P(i,j) * (i - u^2) \quad (6)$$

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

$$\text{Contrast} = \sum_i \sum_j P(i,j) * (i-j)^2 \quad (8)$$

$$\text{Entropy} = \sum_i \sum_j -P(i,j) * \log_e P(\text{i, j}) \quad (9)$$

$$\text{Angular Second Moment} = \sum_i \sum_j P(i,j)^2 \quad (10)$$

$$\text{Correlation} = \sum_i \sum_j (i - u_x) * (j - u_y) * P(i,j) \quad (11)$$

Shape Feature Extraction Techniques: Basically shape describes outlines and entire area of an image. This technique is divided into two parts one is region based (defines whole area of an object) and other is contour based (describes only boundary lines) [23].

A.Zernike moments (ZMs): ZMs are basically anoverall descriptor therefore doesn't provide local characteristics of an image. ZMs are a good descriptor in the various fields like pattern recognition, character identification, image fetching, image reconstruction, vehicle recognition etc. [23].

B.MPEG-7 descriptors: The MPEG-7 are divided into the following types: RSD (region shape descriptor), CSD (contour shape descriptor), 3-D shape descriptor. RSD introduces pixel distribution within a 2D object. It is depends on internal pixels and boundary. CSD is based on representation of the contour in the curvature scale space. Among these, 3D shape descriptors are preferred because of their major application in real world.[24].

III. BASIC CONCEPT OF INTEGRATION (COLOR, TEXTURE AND SHAPE FEATURES)

CBIRS is a searching technology which is applied on databases by using their contents like color, texture and shape. If we use one attribute, it is quite difficult to achieve accurate result. Integration of color, texture and shape features brings better and effectiveness results than all other system [6]. The steps for image retrieval are as follows: 1) Using different techniques for color, texture and shape feature extraction is done.2) Calculation of similarity based on any distance metric 3) After that, fusion of each feature depending on linking algorithm to be used. 4) Evaluation of fusion based results 5) Finally, obtain evaluation metrics in the form of precision and recall [6].

IV. SIMILARITY MEASUREMENT

To obtain similarity between any query image and database images, various distance metrics are used. These distance metrics computes the difference between database image feature vector and query image feature vector. Smaller the distance, similarity between two images will be more. Various distance performance parameters are used such as, Euclidean distance, Manhattan, KL distance and Mahalanobis distance etc.[5].

A.Euclidean distance: The most popular and widely used similarity measure in image retrieval is Euclidean and is given by:

$$D_E = \sqrt{\sum_{i=1}^{n}(|I_i - D_i)^2|} \quad (12)$$

*B. City block distance:*This method also called by the name of Manhattan distance and is expressed by the following given equation:

$$D_C = \sum_{i=1}^{n}|I_i - D_i| \quad (13)$$

*C.Minkowski distance:*This distance is calculated by the expression given below:

$$D_M = [\sum_{i=1}^{n}(|I_i - D_i|)] \quad ^{\frac{1}{P}} \quad (14)$$

*Performance evaluation metrics:*To examine the performance with an image retrieval systems two major evaluation metrics, Precision and Recall are used [5].

Precision: $P = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ images\ retrieved}$ (15)

Recall: $R = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ images\ in\ the\ database}$ (16)

V. RELATED WORK

NaushadVarish et al, proposed a CBIR system based on discrete cosine transformation (DCT) and Grey Level Co-occurrence Matrix (GLCM). By using a hybrid CBIR system based on DC and GLCM, the accuracy of a system is improved. Corel (1k) dataset has been used in which there are 1000 images. The highest precision (100) is obtained [22]. Annrose J. and S. C, presented two different methods to reduce the time and space constraints. In the first method, structured query language (SQL) is used for feature selection for creating normalized feature set through which an efficient CBIR system is developed. In the second method, SQL range query and Euclidean distance are used to filter out initial level relevant image and to smooth the filtered subspace to obtain the relevant image. The experiment is performed on Corel dataset and lowest retrieval time (1.11s) is obtained [2].P. Chandana et al. introduced GLCM technique for texture features extraction in which conversion of the test and query image into grey level image takes place and then extracting texture features. After that similarity distance is calculated by Euclidean distance measure and KL divergence approach. Highest precision (98.67) is obtained [3].G.S. Priyadharshini et al. proposed a system based on Dominant Color Descriptor. By using Dominant Color Descriptor, color details were extracted and therefore, performance of CBIR system is improved up to 62% [4].Y. Mistry et al. introduced Hybrid scheme for CBIR using several distance metrics. For spatial domain features like color auto-correlogram, color moments, HSV histogram features and for frequency domain features SWT, Gabor wavelet transform, CEDD and BSIF features are used to improve precision. Wang dataset is used in which 1000 images are containing with 10 different subjects. By using hybrid scheme highest precision are obtained in Euclidean distance (0.99), city block (0.98), minkowski (0.94), mahalanobis (0.95) [5].Ali Ahmed Alfaki et al. introduced two techniques: HSV color moment for color feature extraction and Gabor technique for the texture features extraction. This paper provides combination of texture and color features. The mean similarity for hybrid method (0.656 and 0.576 for top 10 and top 20) are retrieved [6].Jigisha M. Patel et al. introducedcolor and texture feature and discussed their comparison. Extraction techniques like color histogram, color correlogram, color co-occurrence matrix are used for color features extraction and Tamura texture feature, steerable pyramid, wavelet transform, Gabor wavelet transform are used for texture feature extraction [8].Nitish Kumar Saini et al. introduced an integration of color moment (CM) and local binary pattern (LBP) which is used for color feature and texture feature extraction and tested on wang and UCID databases which contained 1000 images [9].T. Karthikeyan et al. introduced both systems: TBIRS and CBIRS. Just because of some limitations in TBIRS such as task of determining image content, CBIR system came to the lime light to solve this problem. CBIR deliverhigherefficiency in covering the semantic gap between high level human intelligence and basic low level features. [12].S. Mangijao Singh et al. introduced color moments (CM) and Gabor texture features (GTF). For encoding, a minimal amount of spatial information, we divide the space of an image as three equal regions which are non-overlapping horizontal manner to improve the color indexing techniques. Average retrieval of: GTF (43.6); CMW (55.4); CMW+GTF (58.2) [13].

VI. APPLICATIONS

In biometric Security, these systems are focused on recognizing humans depending on their notable physical and

behavioral traits. These days biometric security is used in various fields as per the requirements [20].In medical field, for diagnostics and therapy; images and digitized images are generated in more quantity [18]. In crime Prevention, to identify the criminals through CCTV camera and find out their complete information from database. In military domain, recognition of target from satellite photographs, identification of enemy aircraft by using radar screen. In Digital Library, various digital libraries are used to support services based on image content like, geographical and historical. In Fashion and interior design, retrieving pattern, specific combination of color and texture provide important aids in designing process.

VII. CONCLUSION AND FUTURE SCOPE

The review paper describes basics of CBIR system and its main features characterized by color, texture and shape. As compared to traditional methods, the integration of features provides more accurate results as discussed in fusion section. The retrieval time using fusion method is better than the other methods. The advantage offusion technique is that this is best suitable for large databases. The future scope of the above discussed systems is that issues related optimization and machine learning can be implemented in the basic CBIR systems to make them more relevant in the process of retrieval. It can be applied on various databases such as, COREL (5k, 10k), WANG.

REFERENCES

[1] M. Lande, P. Bhanodiya and P. Jain, "An Effective Content-Based Image Retrieval Using Color, Texture and Shape Feature", Intelligent Computing, Networking, and Informatics, pp. 1163-1170, 2013.

[2] A. J. and S. C., "An efficient image retrieval system with structured query based feature selection and filtering initial level relevant images using range query", Optik - International Journal for Light and Electron Optics, vol. 157, pp. 1053-1064, 2018.

[3] P. Chandana, P. SrinivasRao, C. Satyanarayana, Y. Srinivas and A. GauthamiLatha, "An Efficient Content-Based Image Retrieval (CBIR) Using GLCM for Feature Extraction", Advances in Intelligent Systems and Computing, Vol 555, pp. 21-30, 2017.

[4] Priyadharshini, G. S., T. SreeSharmila, and L. K. Pavithra. "Color Clustering Based Color Feature Extraction in Content Based Image Retrieval ", International Journal of Computer and Mathematical Science, Vol. 6, pp. 1-4, 2017.

[5] Y. Mistry, D. Ingole and M. Ingole, "Content based image retrieval using hybrid features and various distance metric", Journal of Electrical system and Information Technology, pp. 1-15, 2017.

[6] Ali Ahmed Alfaki et al."Color and texture fusion-based method for content-based image Retrieval."Communication, Control, Computing and Electronics Engineering International Conference, pp. 1-6, 2017.

[7] KavitaChauhan and S. Sharma, "Analysis and Optimization of Feature Extraction Techniques for Content Based Image Retrieval", Advances in Intelligent Systems and Computing, Vol 435,pp. 357-365, 2016.

[8] Patel, Jigisha M., and Nikunj C. Gamit. "A review on feature extraction techniques in content based image retrieval." Wireless Communications Signal Processing and Networking (WiSPNET), International Conference, pp 1-5, 2016.

[9] Nitish Kumar Saini and DiwakerMourya, "An Integrated Approach to Content based Image Retrieval", International Journal of Engineering Research and Technology, vol. 5, no. 05, 2016.

[10] D. Meireles Cardoso, G. Giraldi and L. Pereira Neves, "Integrating Content-Based Image Retrieval into SBIM System", IEEE Latin America Transactions, vol. 13, no. 8, pp. 2763-2769, 2015.

[11] Rupali Sharma, Er. Navdeep Singh, "Comparative Study of Different Low Level Feature Extraction Techniques", International Journal of Engineering Research & Technology, Vol. 3 Issue 4, pp 1-7,April, 2014 .

[12] T. Karthikeyan et al.,"A Survey on Text and Content Based Image Retrieval System for Image Mining", International Journal of Engineering Research & Technology (IJERT), Vol 3, pp. 1-4, 2014.

[13] S. MangijaoSingh and K. Hemachandran, "Content based Image Retrieval based on the integration of Color Histogram, Color Moment and Gabor Texture", International Journal of Computer Applications, vol. 59, no. 17, pp. 13-22, 2012.

[14] M. ElAlami, "A new matching strategy for content based image retrieval system", 2018.

[15] J. Yue, Z. Li, L. Liu and Z. Fu, "Content-based image retrieval using color and texture fused features", Mathematical and Computer Modelling, vol. 54, no. 3-4, pp. 1121-1127, 2011.

[16] C. Lin, R. Chen and Y. Chan, "A smart content-based image retrieval system based on color and texture feature", Image and Vision Computing, vol. 27, no. 6, pp. 658-665, 2009.

[17] L. Piras and G. Giacinto, "Information fusion in content based image retrieval: A comprehensive overview", Information Fusion, vol. 37, pp. 50-60, 2017.

[18] H. Müller, N. Michoux, D. Bandon and A. Geissbuhler, "A review of content-based image retrieval systems in medical applications—clinical benefits and future directions", International Journal of Medical Informatics, vol. 73, no. 1, pp. 1-23, 2004.

[19] C. Lin, R. Chen and Y. Chan, "A smart content-based image retrieval system based on color and texture feature", Image and Vision Computing, vol. 27, no. 6, pp. 658-665, 2009.

[20] K. Iqbal, M. Odetayo and A. James, "Content-based image retrieval approach for biometric security using colour, texture and shape features controlled by fuzzy heuristics", Journal of Computer and System Sciences, vol. 78, no. 4, pp. 1258-1277, 2012.

[21] M. Imran, R. Hashim and N. Khalid, "Color Histogram and First Order Statistics for Content Based Image Retrieval", Advances in Intelligent Systems and Computing, pp. 153-162, 2014.

[22] N. Varish and A. Pal, "A novel image retrieval scheme using gray level co-occurrence matrix descriptors of discrete cosine transform based residual image", Applied Intelligence, 2018.

[23] A. Goyal and E. Walia, "Variants of dense descriptors and Zernike moments as features for accurate shape-based image retrieval", Signal, Image and Video Processing, vol. 8, no. 7, pp. 1273-1289, 2012.

[24] R. Kapela and A. Rybarczyk, "Real-time shape description system based on MPEG-7 descriptors", Journal of Systems Architecture, vol. 53, no. 9, pp. 602-618, 2007.

[25] Kaur, Manpreet, and NeelofarSohi. "A novel technique for content based image retrieval using color, texture and edge features." International Conference Communication and Electronics Systems (ICCES), pp. 1-7, 2016.

[26] KavitaChauhan and S. Sharma, "Analysis and Optimization of Feature Extraction Techniques for Content Based Image Retrieval", Advances in Intelligent Systems and Computing, pp. 357-365, 2016.