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A Bird's Eye View on Current Scenario of Content Based Image Retrieval Systems

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***Abstract**: The advancement in technology such as digital imaging, data storage and widespread use of internet has resulted in the explosion of the collection of images which has motivated the creation of an efficient image retrieval system. The Content based image retrieval has proved to be an efficientimage retrieval system for retrieving the database images that exhibit similarity to the query image presented by the user. The retrieval process is carried out by low level feature extraction from the image such as colour, texture and shape. This paper gives an idea about Content based image retrieval system(CBIR), literature survey of CBIR techniques and challenges faced by CBIR system.*

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I. Introduction

With the advancement in Science and Technology and a widespread use of internet to fulfil the increasing demand of mankind for acquiring relevant information from huge databases for various applications has led to the necessity for an efficient retrieval system for extracting the relevant images from large image database. Applications such as Medical diagnosis, Fashion Designing, Crime Prevention, Geospatial Satellite Imagery, Face recognition, Architectural and Engineering design, Textile industry, Face recognition and a lot more require a fast and efficient system to help in retrieving the relevant images from a huge image database containing enormous amount of images. Previously, Text based image retrieval systems (TBIR) were employed that required the manual annotation of images with text which was time consuming and impossible for very large databases. Commercial systems such as Google employed TBIR for retrieving images from databases. The varied human perception of describing the images poses a limitation on TBIR.

Content based Image Retrieval (CBIR) system overcomes the challenges faced by TBIR systems. CBIR system aims at retrieving the relevant images to the user's query from a database of several images by low level feature extractioninstead of keywords. The similarity computation between query image and images in the database is carried out for extracting the desired image. CBIR is also popularly known as Query by Image Content(QBIC) and Content Based Visual Information Retrieval(CBVIR). It is a computer vision application aimed at solving the problem of searching digital images in large databases. In 1992 T. Kato coined the word content based image retrieval as a description forautomatic image retrieval from a database extracting colour and shape feature. IBM developed the earliest CBIR system popularly known as QBIC. The various commercial CBIR systems are QBIC, Virage, VisualSEEK, Netra, Photobook and SIMPLIcity. The databases containing enormous number of images are medical databases used for medical diagnosis of a disease, Geographical Information systems(GIS) used for remote sensing purposes, art gallery, museum catalogues, online shopping catalogues, Industrial Imaging, AIA(Automates Imaging /Machine Vision), ASPRES(Remote sensing program), Wang database, Corel database of images, Multimedia and graphical images, Face Recognition system used by the police personnel. Over the years, plenty of research has been carried out on CBIR systems to improve the retrieval efficiency, speed, accuracy and precision values to reduce the image retrieval time and increase the effectiveness of image retrieval from huge databases. Despite of the research carried so far CBIR still faces some challenges such as subjectivity of human perception of visual content. Gap between information extracted automatically from visual data and interpretation by the user known as semantic gap. The current CBIR systems still lack accuracy of relevant images due to improper selection of feature extraction methods and similarity measurement technique.

Over several years various techniques for image retrieval have been used and implemented but CBIR still suffers from challenges such as semantic gap and varied interpretation ofvisual data by different users. Yogita Mistry et al. [2] proposed a CBIR based on hybrid feature using various distance measure. Kommineni Jenni et al. [1] proposed the application of support vector machine as an image classifier for CBIR and the color string coding and string comparison for extracting features. Hassan Farsi et al. [3] proposed image retrieval by extractingcolor and texture usingHadamard matrix in discrete wavelet transform. AbdolraheemKhaderAlhassan et al. [4] employed different fusion methods for combiningcolour and texture features extracted fromimage. CombMEAN fusion exhibits best results. K. Seetharaman et al. [5] proposed the concept of Full Range Autoregressive model (FRAR), statistical model and radial basis function neural network for colour feature extraction.

Mutasem K. Aslamadi et al. [7] proposed an efficient similarity measure for CBIR using memetic algorithm. The results were superior to other CBIR in regard to precision. HebaAboulmagd et al. [8] proposed the use of fuzzy logic to improve CBIR. Kashif Iqbal et al. [9] proposed CBIR for the application of biometric security by employing fuzzy heuristics for extracting colour, texture and shape features. B. Verma et al. [10] proposed the fusion of color and texture features using fuzzy neural approach. Jun Yue et al. [11] proposed CBIR using color and texture fused features. CBIR that combines the color and texture features greatly improves the performance.

II. Working of Crib System

CBIR performs the task of relevant image retrievalfrom database of images by extracting the low level features from the query and database images. CBIR involves the following steps:

Step1: Query Image is input by the user.

Step 2: The extraction of low level features such as colour, texture and shape from the query image as well as database images is performed.

Step 3: Feature vector is formed from the low level features extracted.

Step 4: The database image feature vectors of are stored in a binary file.

Step 5: The similarity between query image and database images is computed to obtain the most relevant images from the database.

Step 6: The database images are arranged in ascending order corresponding to their similarity evaluation.

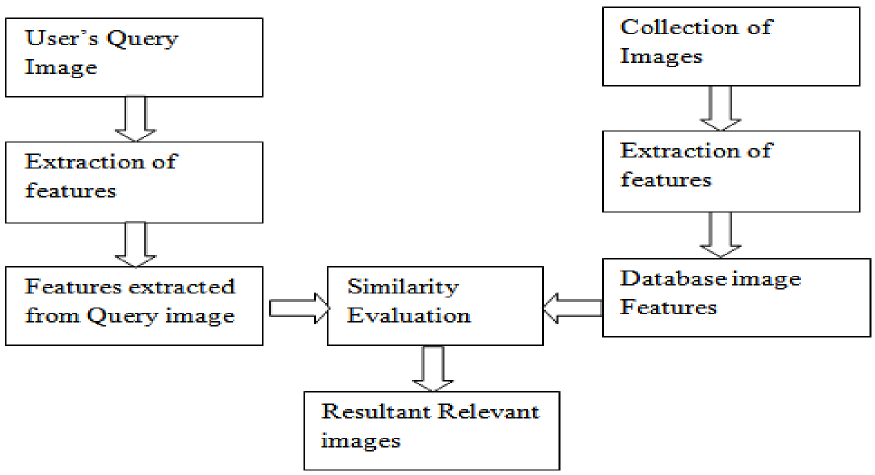

Fig 1: Basic Block Diagram of CBIR System

III. Low low level features

A. Color

Colour is the most prominent and important feature of an image. Colour feature is a dominant descriptor due to its reduced computational complexity, and invariant behaviour to changes in rotation, translation and scale and viewing angle. Colour Histogram technique employed for colour feature extraction is most commonly employed technique. The drawback of colour histogram method is the lack of spatial information and give the same histogram representations for entirely different images[1]. Colour space represents the range of colours and is used for colour feature extraction. RGB is a three dimensional colour space that consist of red, green and blue as primary colours. HSV colour space where H represents hue, V represents value or greyscale image intensity and S represents saturation. Other colour spaces are CIE L*a*b*, CIE L*u*v*. Other colour feature extraction techniques are colour Correlogram, Dominant Colour Descriptor, Colour moments, and Colour Co-occurance matrix.

b. c d.

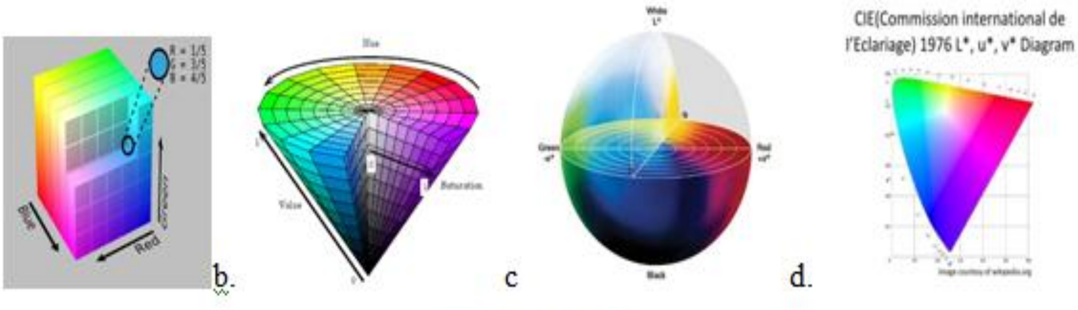

Fig 2: Color Spaces

B. Texture

Texture feature gives a description about the structural arrangement of surface geometry. Texture describes properties such as coarseness, contrast, regularity , smoothness, directionality. Texture feature provides spatial information unlike colour. Texture description can be given in terms of some approaches i.e. statistical, approach in which statistical properties osurface image are used to categorize texture with the help of gray scale. Here Co-occurrence matrix and wavelet transformmation is used. The structural apprioach uses texel or texture elements . Spectral techniques such as fourier spectrum is used to explain the global periodicity of surface. Various texture feature extraction techniqes are Tamura texture feature, SSteerable Pyramid, Wavelet Transform, Gabor wavelet Transform, Local binary pattern, Curvelet Transform.

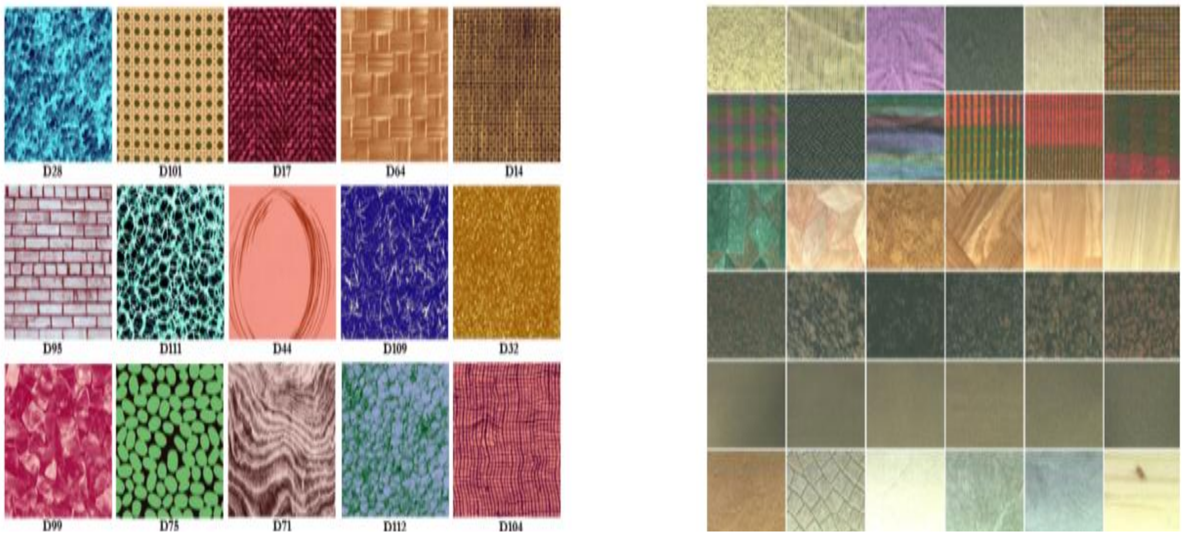

Fig 3: Texture Feature

C. Shape

Shape represents the contour of an object. Shape enables the object to look different from its surroundings. The representation of the outer boundary of shape is called as boundary based shape representation and region based shape representation covers the entire shape region. Boundary based shape feature extraction techniques are Fourier descriptors, polygonal model, splines, polygonal, boundary partitioning, higher order constructs and curvature model. Region based feature extraction techniques are Fourier descriptors, Blum's skeletons, implicit polynomials and super quadrics. Canny edge detection, moment invariants and Fourier descriptors are most popular shape feature extraction techniques.

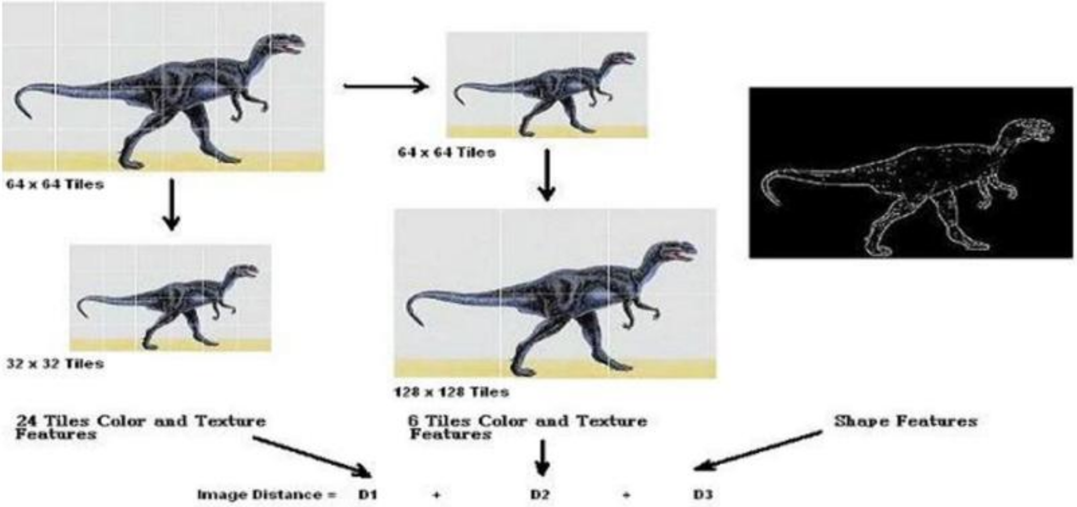

Fig 4: Shape Feature

IV. Colour Feature extraction techniques

a) Colour Histogram

The most common colour feature extraction technique is Colour Histogram. Colour histograms are computationally efficient. They are insensitive to rotation and translation changes[12]. HSV histogram computation is carried out in three steps namely conversion of colour space, quantization and computation of histogram.The main drawback of colour histogram technique is the inability toprovide spatial information.Also there are increased chances of two completely different images having the same histogram representation due to same distribution of colour. Colour histogram gives the colour pixel probability in an image. Bar graph representation is used for colour histogram computation. The bins are represented along x-axis whereas the y-axis represents the number of pixels that belong to a particular bin[22].

b) Colour auto-correlogram

Unlike colour histogram Colour auto-correlogram provides spatial information combined with colour histogram. It represents the variation of colour with respect to distance[2]. The autocorrelation of colors in spatial plane is given. One of the disadvantages of colour auto-correlogram is slow speed of computation as it requires the evaluation of all neighbouring pixels[2].

c) Colour moments

Colour moments computation is performed by using probability distribution technique. Mean, median, skewness and variance are computed. 9 moments are used to characterize an image.

d) Dominant Colour descriptor

It describes the dominant colour in some specific portion of an image. The retrieval of images from the database is carried out by using a particular colour or a group of colour values. It is more advantageous compared to histogram techniques[12].

V. Texture feature extraction techniques

a) Tamura texture feature

Six textual features namely coarseness, contrast, directionality, line-likeness, regularity and roughness are used by Tamura feature. The contrast describes the range of grey levels with polarisation of black and white distribution. The angle and magnitude are counted at each pixel[12]

b) Steerable Pyramid

The steerable pyramid extracts texture feature by dividing image into a set of sub bands. The image is divided into a set of undecimated directional sub-bands and one decimated lowpass sub-bands[13].

c) Gabor wavelet transform

Gabor wavelet transform is an efficient methodas it provides information regarding spatial and frequency domain. The local spatial frequencies are measured using multi resolution and multi orientation properties.

d) Wavelet Transform

The multi resolution approach is used by wavelet transform for texture analysis and classification. An image in wavelet transform is decomposed using shifted and dilated functions. A filter bank is employed to each row and column of image and to each row of the resultant coefficient to obtain a 2-D discrete wavelet transform [22].

VI. Similarity Measurement

The evaluation of similarity between the features of query image and database images is computed by various metrics such as Euclidean distance City block distance, Minkowski distance and Mahalanobis distance[2]. Recently researchers have used various algorithms for similarity measurement such as memetic algorithms that have proved to be more efficient in computing similarity than the conventional similarity evaluation methods.

VII. Performance evaluation parameters

The evaluation of system performance is carried out with the aid of various measures such as average precision, recall and retrieval speed. Precision andrecall values are examined for each query image. The precision is defined as the fraction of the retrieved images of relevance to the query:

$$\text{Precision} = \frac{\text{Total no.of retrieved relevant images}}{\text{Total no.of retrieved image}s}$$

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

$$\text{Recall}=\frac{\text{Total no.of retrieved relevant images}}{\text{Total no.of all databaseimages that are relevant}}$$

VIII. Literature Survey

A CBIR system based on Colour strings comparison was proposed. Database was classified using Support Vector Machine Classifier in order to obtain different classes.Features extraction is performed using colour string coding and comparison method.Database classification improves the performance and colour string coding gives better results [1]. A hybrid feature based efficient CBIR system was proposed using various distance metrics. Spatial domain features such as color auto-correlogram, color moments, HSV histogram features and frequency domain features such as moments using SWT and Gabor wavelet transform were used. The precision was improved by using binarized statistical image features, Colour and Edge directivity descriptor features. WANG database containing 1000 images was used. Similarity measurement was done using Euclidean distance, City block distance, Minkowskidistance and Malabonis distance. High precision was achieved by using BSIF and CEDD descriptor [2]. Colour, texture and shape features were extracted using Colour histogram, Gabor wavelet and moment invariant respectively. Better results are exhibited by proposed methodology [3]. Full Range Autoregressive (FRAR) Model for extracting colour feature was proposed. Bayesian Approach(BA)estimates the parameters of FRAR. Radial Basis function neural network(RBFNN) is used for feature vector database characterization. The improved EHD and compact MTs yield better results compared to that of MPEG-7s EHD, HTD and conventional MTs[5]. The genetic algorithm with great delugefor computation of similarity between QI and the database image features is obtained. Corel image database was used. The results show 0.882 and 0.7002 as the average precision and recall rates[7]. A CBIR system using colour and texture fused features was developed in which colour and texture features were extracted by employing colour histogram and co-occurrence matrix to form feature vectors.The comparison and analysis between global colour histogram, local colour histogram and texture features was performed. Also a CBIR system using colour and texture fused features was designed. Experiments showed that retrieval by fused feature shows better retrieval results [11]. The overview of various techniques used for extracting colour and Texture was given. Colour feature extraction techniques are Color histogram, colorCorrelogram, color co-occurance matrix and Dominant Color descriptor. Texture feature extraction techniques are Tamura teaxture feature, steerable pyramid, wavelet Transform, Gabor wavelet Transform. A comparative analysis of color and texture feature extraction techniques withh their advantages and disadvantages was given [12]. A new evaluation of similarity using metaheuristic algorithm is implemented. The addition of GA and ILS algorithm has iproved the performance by increment of fitness function. Precision of 0.8883 and recall rate of 0.7125 were achieved [15]. Interactive Genetic Algorithm was proposed to obtain higher level of accuracy. In the query stage, the query features were extracted and the similarity between the query image and database image features was evaluated. In the evolution stage, the most relevant images were retrieved using Interactive Genetic Algorithm. IGA provides an interactive mechanism to effectively capture the user's intention [16]. Human perception is ignored by low level features. Aim of research is to reduce the semantic gap between low and high level features. The low level features(color, texture and shape) were extracted and Relevance feedback and adaptive clustering were applied thus, reducing the gap between low and high level features. Also The various approaches used for [18]. A fusion based retrieval model for combining color and texture image features based different fusion methods was proposed. The colour feature extraction using Colour moment and Texture feature extraction using Gabor wavelet transform was done. Precision values were calculated. Wang database was used. Results proved that CombMEAN fusion approach had the highest precision value [19]. Image segmentation is the classification of an image into different groups. The desired area from the background is segmented with the aid of an unsupervised algorithm called K-means clustering algorithm. Subtractive clustering was used to generate the initial centres and these centres were used in k-means algorithm for segmentation of image. Median filter was applied to segmented image to remove any unwanted region from the image. A small value of RMSE and large value of PSNR which ensure good quality image segmentation [21]. CBIR system in which low level features such as color, texture and shape feature extraction was implemented. CBIR system was implemented using MATLAB software. Experiments show that colour feature extraction is not very efficient. Image retrieval using co-occurrence matrix gives good results for images that contain structures. Wavelet packet decomposition outperforms co-occurrence matrix. For images with objects of specific shape Boundary scanning technique exhibits good results. Optimum weights for features are decided empirically [22]. The improvement in the precision of CBIR system using Binary Search Algorithm was proposed. Gravitational search algorithm was compared with genetic algorithm and particle swarm optimization in feature selection. Comparative studies show that BGSA exhibits higher precision compared to BPSO and GA[23]. A scheme in which the colour feature was extracted using Colour Moment(CM) and texture feature was extracted using Local Binary Pattern(LBP) technique. A combination of colour and Texture feature is used for the formation of single feature vector. The similarity between the features of query image and database image is computed using Euclidean distance. Here, LBP was used on natural images to extract texture feature [24]. Research ontexture feature extraction using multi-scale analysis especially the curvelet transform provided high accuracy.The discrete curvelet transform was applied for texture feature extraction of images. Results show that Curvelet transform outperforms Gabor texture feature extraction [29]. Relevance feedback provides an adaptive retrieval approach that bridges the gap between lowand high level features by employing user's feedback for proper assignment of weights to the user and to enable dynamic selection for large collection of parameters. The new relevance feedback approach with feature adaptation shows a significant improvement in retrieval accuracy compared to the standard RF approaches[30]. Research has been carried out for the retrieval of incomplete and distorted queries. The query images in which these is absence of some information, presence of undesirable objects, blurring, noise due to disturbance at the time of image acquisition are called incomplete or distorted mages. Colour feature extraction is performed using HSV colour space, shape feature extraction is performed using Moment Invariantand Fourier descriptor. The results exhibit an increase in retrieval accuracy attaining a precision of 79.87 %due to colour and shape feature fusion[34]. Colour Edge detection and discrete wavelet transform was employed. The colour and edge features were combined using this technique. The wavelet transform was used for reducing the feature vectors size. Experimental results exhibit the robustness to alteration of image by intensity variations, sharpness variations, cropping, shifting and rotation[35].

IX. Challenges faced by current Crib systems

The current CBIR systems are still lack in accuracy of relevant image due to theimproper selection of feature extraction methods and similarity measurement.Gap between information extracted automatically from the visual data and interpretationby the user which is known as Semantic gap.Subjectivity of human perception of visual content.

X. Conclusion and Future scope

CBIR has outperformed the traditional image retrieval systems by reducing the retrieval time and improving the efficiency of retrieving more relevant images from the database.

Efforts have been made to overcome the semantic gap by using various techniques such as Relevance feedback, machine learning, object ontology, semantic template. Now research is being carried out on CBIR using colour, texture and shape fused low level features, CBIR using fuzzy logic, metaheuristic algorithms for similarity measurement, CBIR using high level features, multidimensional features and Use of machine learning and relevance feedback to overcome semantic gap. With an objective to further improve the precision recall values and retrieval accuracy in less time research is being carried out on CBIR.

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