CHAPTER 2

LITERATURE SURVEY

In this section, the recent approaches and methodologies in the area of CBIR and CBMIR systems are discussed.

2.1 SEMANTIC GAP

Most CBIR systems are intrinsically constrained by low-level features which are used to describe the content of digital images. These low-level features cannot adequately express the user’s high-level concepts leading to substandard results and this problem is termed as the Semantic Gap [JSH2006]. In general, semantic gap is the inability to reunite high-level concepts as perceived by users and low-level features that are used to describe the content of the images.

To eradicate the semantic gap, the recent solution can be categorized into three main approaches. The first approach is based on image database categorization [SGU1998] [AHI1998] [SME1998] [AKH2001] [NGR2005], the concept is to partition the image database into clusters of similar images. In the process of retrieval, clusters that are similar to query image are searched. Thus if images contained in each cluster are semantically similar, the images that are retrieved will also be semantically similar. Various clustering algorithms are proposed for this task which focus on to learn relevant features for each category, and use partial supervision information to steer the clustering process [KWA2000] [SBA2003] [SBA2004] [NGR2005] [RGE2007] [HFR2008].

The second approach is based on relevance feedback [HJZ2002]. A traditional image retrieval technique begins by using the QBE approach [AKU2004], in which user provides the system with an example image and the outcome is set of images that are visually similar to the query image. Then user checks the relevancy of retrieved images to their interests. This can be accomplished by allowing user to set flag any number of returned
images as either + ve (relevant) or – ve (irrelevant) [SSA2000] [JUR2003] [ZHZ2006]. The third approach includes annotating the images and represents them by textual features to support text-based queries. This process can be done manually, but this is tiresome and is not practical for large image databases.

Duygulus et al. [PDU2002], treated the problem of image annotation as a machine translation from one form into another form (may be from region to words). Barnard et al. [KBA2003] proposed another image annotation approach, in which a number of models are used to describe the distribution of image regions and words and separate set of models are used to ascertain correspondence.

T. R. Sontakke et al. [TRS2012] proposed an effective approach to trim down the semantic gap. Initially, when a query image is given, images relevant to it are retrieved from the image database based on its low level features. The retrieval is performed utilizing one of the evolutionary algorithms called Evolutionary Programming. Subsequent to this process, query keyword which is a high level feature is extracted from these retrieved images and then based on this query keyword, relevant images are retrieved from the database. Afterwards, the images retrieved based on low level features and high level features are compared and the images which are both visually and semantically identical are identified. Better results obtained by the proposed approach when it is queried using different types of images prove its effectiveness in minimizing the semantic gap.

H. H. Wang et al. [HHW2010] proposed a novel technique for objects spatial relationships semantics extraction and representation among objects existing in images. All objects are identified based on low level features extraction integrated with proposed line detection techniques. Objects are represented using a Minimum Bound Region (MBR) with a reference coordinate. The reference coordinate is used to compute the spatial relation among objects. There are 8 spatial relationship concepts determined as: “Front”, “Back”, “Right”, “Left”, “Right-Front”, “Left-Front”, “Right-Back”, “Left-Back”,
“Left-Back”. The user query in text form is automatically translated to semantic meaning and representation. Besides this, the image similarity of objects spatial relationships semantic has been proposed.

C. Y. Lin et al. [CYL2006] proposed a multi-level semantic modeling method, which integrates Support Vector Machines (SVM) into Hybrid Bayesian Networks (HBN). SVM discretizes the continuous variables of medical image features by classifying them into finite states as middle-level semantics. Based on the HBN, the semantic model for medical image semantic retrieval can be designed at multi-level semantics. To validate the method, a model is built to achieve automatic image annotation at the content level from a small set of MRI (magnetic resonance imaging) samples. Multi-level annotation is a promising solution to enable medical image retrieval at different semantic levels. Experiment results show that this approach is very effective to enable multi-level interpretation of MRI scan. It outperforms the Bayesian network-based model using k-Nearest Neighbor classifiers (K-NN). This study provides a novel way to bridge the gap between the high-level semantics and the low-level image features.

Qing- Zhu Wang et al. [QWA2010] presented a medical image retrieval system combined of the low-level image feature and high-level semantic which includes two main parts: image preprocessing and the machine learning. In the first part, feature tree structure is presented to reduce the semantic gap and in the latter part, a novel machine learning method based on SVM is presented to optimize the Network parameters which improve the effect of semantic annotation and recognition rate.

C. Pulla et al. [CPU2010] discussed that semantic analysis of a document collection can be seen as an unsupervised clustering of the constituent words and documents around as hidden or latent concepts. This in turn improves the performance of visual bag of words in image retrieval. However, the improvement in performance depends heavily on the right choice of number of semantic concepts. The semantic indexing schemes may be computationally costly. In this research work, a Bipartite Graph Model
(BGM) for image retrieval is proposed. BGM is a scalable data structure that aids semantic indexing in a proficient manner which can be updated incrementally. A graph partitioning algorithm is also presented that works on the BGM to retrieve semantically similar images from the database. Through a series of experiments, the properties as well as performance of semantic indexing scheme is demonstrated.

Many researchers have proposed a variety of methods to bridge or narrow the semantic gap existing in content-based image retrieval. The methods include two types: bottom-up and top-down approaches. These approaches have made great progress, but few studies have been done in how to measure it. Chengjung Liu et al. [CLI2011] redefine the semantic gap in a user-centered way and present a method for measuring the semantic gap, using the information theory.

### 2.2 IMAGE QUALITY MEASURE

Objective measures such as Mean Squared Error (MSE) and MSE-based measures: Peak Signal to Noise Ratio (PSNR) and Signal to Noise Ratio (SNR) are generally used. These measures perform well when images are compared with the same type of degradation.

It has been observed that in case of images with same type of distortion, image with smaller MSE will be perceived closer to the original image than the one with greater MSE. However, while dealing with images having different types of degradation, MSE does not produce results that show a relationship well with subjective quality assessment. Moreover, images with different types of degradations with same MSE values can have very different subjective visual qualities.

Many algorithms have been developed with an aim to find a criterion, which agrees with subjective assessment. The algorithms developed in this area are based on the properties of Human Visual System (HVS) which are nonlinear relationship between image intensities and perceived brightness, frequency response of HVS (contrast sensitivity function) and texture.
S. Daly [SDA1993] proposed an algorithm called Visible Difference Predictor (VDP), which describes the human visual response. It is a design tool that can find wide areas of application and intended to be used in the development of image-processing algorithms, imaging system hardware, and imaging media. VDP is based on digital image processing and by using actual images rather than just parameters of the imaging system, it enables the preservation of phase information. This information is necessary to predict visual distortion because of the masking properties of the visual system, in which the location of the image error is important as the magnitude. VDP can be used for all types of image distortions including blur noise, algorithm artifacts, banding, blocking, pixellation, and tone-scale changes.

R.J. Safranck et al. [RJS1989] presented a 16-band sub band coder arranged as four equal-width sub bands in each dimension. An empirically derived perceptual masking model is used to set noise-level targets not only for each sub band but also for each pixel in a given sub band. The noise-level target is used to set the quantization levels in a DPCM (Differential Pulse Code Modulation) quantizer. The output from the DPCM quantizer is then encoded using entropy-based coding scheme, in either 1×1, 1×2 or 2×2 pixel blocks. Using this system, a high-quality output is obtainable.

N. Damera et al. [NDA2000] modelled a degraded image as an original image, which has been subjected to linear frequency distortion and additive noise injection. A Distortion Measure (DM) of the effect of frequency distortion, and a Noise Quality Measure (NQM) of the effect of additive noise is developed. The NQM takes into account the following:

i) Variation in contrast sensitivity with distance, image dimensions and spatial frequency;

ii) Variation in the local luminance mean;

iii) Contrast interaction between spatial frequencies;
iv) Contrast masking effects.

The results depict that for additive noise, NQM is a better measure of visual quality than peak signal-to-noise ratio (PSNR) and linear quality measures. The research work also demonstrated; how to decouple distortion and additive noise degradation in a practical image restoration system.

Both SNR and PSNR are mean squared error measures. SNR is defined as the ratio of average signal power to average noise power. For an $M \times N$ image

$$SNR \ (dB) = 10 \ \log_{10} \ \left( \frac{\sum_{i,j} x(i,j)^2}{\sum_{i,j} (x(i,j) - y(i,j))^2} \right)$$

for $0 \leq i \leq M - 1$ and $0 \leq j \leq N - 1$, where $x(i,j)$ denotes pixel $(i,j)$ of the original image and $y(i,j)$ denotes pixel $(i,j)$ of the noisy image.

PSNR is defined as the ratio of peak signal power to average noise power.

$$PSNR \ (dB) = 10 \ \log_{10} \ \left( \frac{D^2 MN}{\sum_{i,j} (x(i,j) - y(i,j))^2} \right)$$

for $0 \leq i \leq M - 1$ and $0 \leq j \leq N - 1$, where $D$ is the maximum peak to peak swing of the signal (255 for 8-bit images).

T.N. Pappas et al. [TNP1996] presented an overview of image quality measures and investigated different criteria for supra-threshold image compression. The algorithms include JPEG and perceptual JPEG, the Safranck- Johnston perceptual sub band image coder (PIC), and the Said-Pearlman algorithm. A number of performance criteria, which include mean-squared error, Watson’s perceptual metric, a metric based on the PIC coder, as well as an eye-filter weighted mean-squared-error metric is considered during experiments and results indicate that the PIC metric provides the best correlation with subjective evaluation.
Z. Wang et al. [ZWA2002] presented some insights of why image quality assessment is so difficult by pointing out the weaknesses of the error sensitivity based framework, which has been used by most image quality assessment approaches in the past. The philosophy used in designing image quality metrics is that the main function of the human eyes is to extract structural information from the viewing field and the human visual system is highly adapted for this purpose. Therefore, a measurement of structural distortion should be a good approximation of perceived image distortion. Based on this philosophy, a simple but effective image quality indexing algorithm is implemented.

A. C. Bovik et al. [ACB2002] proposed a new universal objective image quality index, which is easy to calculate and applicable to various image processing applications. Instead of using traditional error summation methods, the proposed index is designed by modelling any image distortion as a combination of three factors: loss of correlation, luminance distortion, and contrast distortion. Although the new index is mathematically defined and no human visual system model is explicitly employed, the experiments on various image distortion types indicate that it performs significantly better than the widely used distortion metric mean squared error.

### 2.2.1 IMAGE NOISE

Image noise is the random variation of brightness or color information in images produced by the sensor and circuitry of an image capturing device such as scanner or digital camera [ZWA2002]. Image noise is generally regarded as an undesirable by-product of image capture [BMJ2012]. Image noises are inaudible and actually beneficial in some applications, such as dithering [PSU2011].

**Salt-and-Pepper Noise**

An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. This type of noise can be caused by dead pixels, analog-to-digital converter errors, bit errors in transmission,
etc. It can be mostly eliminated by using dark frame subtraction and interpolating around dark/bright pixels [SFE2008].

**Impulse Noise**

Impulse noise is always independent and uncorrelated to the image pixels and is randomly distributed over the image. In an impulse noise corrupted image, few image pixels will be noisy and the rest of pixels will be noise free [JHA2010]. There are different types of impulse noise namely salt and pepper type of noise and random valued impulse noise. In salt and pepper type of noise, the noisy pixels takes either salt value (gray level -225) or pepper value (grey level -0) and it appears as black and white spots on the images. In case of random valued impulse noise, noise can take any gray level value from zero to 225. In this case, noise is randomly distributed over the entire image and probability of occurrence of any gray level value as noise will be same.

**Additive White Gaussian Noise (AWGN)**

In communication channels, a basic and generally accepted model for thermal noise is the set of assumptions that i) the noise is additive, i.e., the signals which are received equals the transmit signal plus some noise, where the noise is statistically independent of the signal. ii) the noise is white, i.e., the power spectral density is flat, so in time domain the autocorrelation of the noise is zero for any non-zero time offset. iii) the noise samples have a Gaussian Distribution. It is also assumed that the channel is Linear and Time Invariant. AWGN is the statistically random radio noise characterized by a wide frequency range with regards to a signal in a communications channel [LIX2002].

**Multiplicative Speckle Noise**

Speckle is a granular noise that inherently exists in all types of coherent imaging systems (CIS) that record both the amplitude and the phase of the back-scattered radiation. Speckle noise imposes fundamental limitation on
image quality and it reduces the ability of a human observer to resolve fine
details and to detect targets. Speckle noise in conventional radar results
from random fluctuations in the return signal from an object that is no
bigger than a single image-processing element. This type of noise generally
causes difficulties for image interpretation [AGI2008]. Speckle noise in
Synthetic Aperture Radar (SAR) is a multiplicative noise, i.e. it is in direct
proportion to the local grey level in any area. The signal and the noise are
statistically independent of each other. The sample mean and variance of a
single pixel are equal to the mean and variance of the local area that is
centered on that pixel.

**Blurring Noise**

A **Gaussian blur** is the result of blurring an image by a Gaussian function.
It is a widely used effect in graphics software, typically to reduce image noise
and reduce detail [XKA2007]. The visual effect of this blurring technique is a
smooth blur resembling that of viewing the image through a translucent
screen. Mathematically, applying a Gaussian blur to an image is the same
as convolving the image with a Gaussian function; this is also known as a
two-dimensional Weierstrass transform. Applying a Gaussian blur has the
effect of reducing the image’s high-frequency components; a Gaussian blur
is thus a low pass filter.

### 2.3 CONTENT BASED IMAGE RETRIEVAL (CBIR)

In all CBIR systems appropriate feature vector in a feature space is used to
represent the images. These feature vectors provides meaningful information
of the image properties and also plays a significant role in the retrieval phase,
as well. The main goal here is to provide relevant result to the user.
Additionally, a similarity measure between images is defined from the
distance between images in the feature space. For a given query image, firstly
the system extracts image feature vector which are then compared to feature
vectors of the images stored in the database. Most of the CBIR systems works
on this approach by ranking images of the database according to the distance of their feature vector to the query [KTR2009] [VNG1995].

M. Smeulders et al. [AWM2000] presented a review of about 200 reference research papers in the field of content-based image retrieval. The discussion is focused on various working conditions of retrieval systems like types of images, semantic role, pattern use and the sensory gap. The different computational steps for image retrieval systems are also highlighted. The image processing for retrieval sorted by color, texture, and local geometry is also reviewed. A broad view of accumulative and global features, salient points, object and shape features, signs, and structural combinations is also presented. Similarity of pictures and objects in pictures is reviewed for each of the feature types, in close connection to the types and means of feedback the user of the systems is capable of giving by interaction.

Amol P. Bhagat et al. [APB2012] presented a novel framework for combining color, texture and shape information to achieve higher retrieval efficiency. The image is partitioned into non-overlapping tiles of equal size. In this approach the moments related to color and geometry serve as local descriptors of color and texture respectively. For getting details of the same image, the local information is captured for two resolutions and two grid layouts. Image Segmentation is used for shape matching, where shape information is captured in terms of edge images. The combination of the color, texture and shape features provide a robust feature set for content-based image retrieval system. The parameters like precision and time required for retrieval are used for comparisons which are based on histogram and simplicity. Color moments, local color histogram and global color histogram methods are used for color feature extraction while co-occurrence method is used for extracting texture features from image.

Sherin M. Youssef et al. [SMY2012] proposed three new image retrieval systems to retrieve the images using color and texture features. The image is divided into equal sized non-overlapping tiles. To partition the image, Discrete Wavelet Transform, HSV color feature, cumulative color histogram, Dominant
Color Descriptor (DCD) and Gray Level Co-occurrence Matrix (GLCM) are applied. For comparison of the query and database images, an integrated matching scheme based on Most Similar Highest Priority (MSHP) principle is used. The adjacency matrix of a bipartite graph is formed using the sub-blocks of query and images in the database. The proposed techniques compared retrieval schemes in terms of parameters like average precision and average recall. The proposed techniques are proficient to perform scale, translation, and rotation invariant matching between images.

Deying Feng et al. [DFE2013] proposed an efficient indexing method for content-based image retrieval. The proposed method introduces the ordered quantization to increase the distinction among the quantized feature descriptors. These quantized feature descriptors are used for determining the feature point correspondences, and are further used to measure the similarity between query image and database image. A multi-dimensional inverted index is proposed to implement this scheme efficiently.

Nidhi Singh et al. [NSI2012] addressed the problem of content-based image retrieval in dynamic environment. The systems that analyze images in real-time where the images are stored or added on an ongoing basis is not feasible. In this work, a framework which is able to select the most appropriate features to analyze recently received images thereby improving the retrieval accuracy and efficiency is proposed. The algorithm comprises of designing feature vectors after segmentation which will be used in similarity comparison between query image and database images. The framework is trained for different images in the database. In their proposed work, fuzzy C-means algorithm (FCM) approach is used, which generalizes the hard C-means algorithm to allow a point to partially belong to multiple clusters. The Fast Fourier Transform (FFT) is used for feature extraction.

Sanjay Patil et al. [SPA2012] makes a comparison six different distance metrics such as Euclidean, Manhattan, Canberra, Bray-Curtis, Square chord, Square chi-squared distances in order to find the best similarity measure for image retrieval. Energy levels are calculated using pyramid structured wavelet
decomposition. The obtained energy levels are compared by calculating distance between query image and images in the database using above mentioned six different similarity metrics. For retrieval purpose, a large image database from Brodatz album is used. After testing the database using above mentioned technique, the experimental results shows the superiority of Canberra, Bray-Curtis, Square chord, and Square Chi-squared distances over the conventional Euclidean and Manhattan distances.

Lenina Birgale et al. [LBI2006] proposed a novel approach which combines colour and texture features for content based image retrieval. The colour and texture features of the image are obtained by computing the measure of standard deviation in combination with energy on each colour band of image and sub band of wavelet. The Wavelet transform is used for decomposing the image into 2x2 sub bands. A database of 640 visual texture color images is constructed for implementation and testing. After the successful execution of the proposed system, it has been observed that the proposed approach outperforms the other conventional histograms and standard wavelet decomposition techniques.

P.S. Hiremath et al. [PSH2007] presented a novel framework for achieving higher retrieval efficiency by combining all the three i.e. color, texture and shape information. A framework is proposed in which the digital image is partitioned into non-overlapping tiles of equal size. The color moments and moments on gabor filter responses on these tiles serve as local descriptors of color and texture respectively. To provide different details of the same image, the local information is captured for two resolutions and two grid layouts. For matching the images, an integrated matching scheme, based on MSHP principle and the adjacency matrix of a bipartite graph formed using the tiles of query and target image is provided. To capture shape information in terms of edge, images is computed using Gradient Vector Flow fields. To record the shape features, Invariant moments are used.
Alia. A. A. Youssif [AAY2010] proposed a new approach for image retrieval based on color, texture and shape by using pyramid structure wavelet. The major benefit of such an approach is that human intervention is reduced to very little. However, most of these systems only allow a user to query using a complete image with multiple regions but are inefficient to retrieve similar looking images based on a single region. The proposed technique generates the Receiving Operating Characteristic curve (ROC) to assess the results.

P.V. N. Reddy et al. [PVN2011] proposed Local Derivative Pattern (LDP) as a new image indexing and retrieval algorithm. For features vector of each image in the data base, LDP histograms are used. LDP role is to encode the higher order derivative information which contains more detailed discriminative features, thereby make it a powerful tool for feature extraction of images in the database. The system performance is tested in terms of retrieval efficiency and computational complexity and observed improved results shows improvement over their previous CBIR systems based on LBP (Local Binary Patterns) features and LBP correlogram features. In the current system model, the city block distance, Euclidean distance, Canberra distance are used for similarity measurement.

2.4 CONTENT BASED MEDICAL IMAGE RETRIEVAL (CBMIR)

Content Based Medical Image Retrieval (CBMIR) is quite poles apart from Content Based Image Retrieval (CBIR) and the reason is that in medical context, recognizing the specific organs with their relative locations as well as the user’s individualized subjectivity must be considered during retrieval process and matching similarity. Consequently, general CBIR systems provide unsatisfactory results when used within the medical context [ARA2011]. The results are on the poor side when CBIR systems are used to retrieve digital medical image. At present, a large variety of digital medical image are captured by using film scanners, Computed Tomography (CT), Positron Emission Tomography (PET), Single Positron Emission Computed Tomography (SPECT), ultrasounds, Magnetic Resonance Imaging (MRI),
Digital Subtraction Angiography (DSA), and Magnetic Source Imaging (MSI) [LST2012].

To retrieve the medical image from the database in an efficient manner an efficient medical image retrieval system is desperately required which may be able to retrieve similar images from database by inputting a query image. The efficiency of the digital medical image retrieval system largely depends upon the feature selection and its classification. Gongzhu Hu et al. [GHU2008] introduced a method for image retrieval and classification using low-level image features. This method is based on selection of prominent features in the high dimension feature space and the parameter of the k-NN (k samples from nearest neighbour method for image classification and retrieval) algorithm. The non-image features (patient records) are combined with image features to improve the accuracy of the results. Both the patient data and images are from an area of clinical diagnosis on oral cancer patients at Mid-Michigan Medical Center.

Ankita Chandra Kar et al. [ACH2011] presented a novel and hybrid approach for managing a huge medical image database and the medical images are retrieved from the database by fusion of both shape and texture features. In this research work, some document information is attached with each medical image such as patient identity, diseases, age, and case history. It is also helpful for further diagnostic and analysis purpose. Further, when a new query is found, the proposed algorithm also updates the database automatically. The Fourier descriptor (FD) and moment invariants are used to extract shape feature and for measuring texture feature, Gray Level Co-occurrence Matrix (GLCM) technique is used which is computed using the distribution of intensities and the relative positions of the pixels in an image. For similarity measurement between the query image and database image the Euclidean distance is used.

Sasi Kumar et al. [MSK2012] proposed a novel feature selection mechanism using Discrete Sine Transforms (DST) with Information gain for feature
reduction. The simulation results confirm that the proposed Support Vector Machine (SVM) classifier outperforms conventional SVM classifier and multi-layer perceptron neural network.

Kehong Yuan et al. [KYU2011] presented an efficient approach to develop the archives of large brain CT medical data. The medical images are securely acquired along with relevant diagnosis reports, which are then cleansed, validated and enhanced. Afterwards, some sophisticated image processing algorithms including image normalization and registration are applied to make sure that in image matching only, corresponding anatomy regions could be compared. The features are extracted by Non-negative Tensor Factorization (NTF) and associated with each image, which is essential for the content-based medical image retrieval. The experimental results has proved the efficiency and promising prospect of this database building method for computer-aided diagnosis system.

Chien-Shun Lo et al. [CSL2012] reported that Magnetic Resonance (MR) images have been used extensively in clinical trials in recent years because they are safe to the human body and detailed information can be obtained by scanning the same slice with various frequencies and parameters. The aim of their research work is to detect the breast tissues within multi-spectral MR images. A support vector machine (SVM) is applied to breast multi-spectral magnetic resonance images to classify the tissues of the breast. The feasibility and efficiency of proposed method is determined by using classification rate and likelihood ratios that are based on manifold assessment. A series of experiments are conducted and compared with the commonly used C-means (CM) for performance evaluation. The results highlights that the SVM method is a promising and effective spectral technique for MR image classification.

Ashok Vijay et al. [AVI2009] described an efficient approach and algorithm to enable extraction of the key information from the medical images based on their shape. The Generic Fourier Descriptor (GFD) with Brightness is
used as additional parameter to achieve good retrieval accuracy and GFD is obtained after applying 2-D Fourier transform on the image.

K.Rajakumar et al. [KRA2010] reported that in content based medical image retrieval system, the reliability of retrieval results highly depends much on the image features used for measuring image similarity. A new medical image retrieval method using energy efficient wavelet transform is proposed. Wavelet transformation can also be easily extended to 2-D (image) or 3-D (volume) data by successively applying 1-D transformation on different dimensions. The performance analysis is done by comparing with Gabor, Bi-orthogonal, and Haar Wavelet. To check the image relevancy between query image and image within database, the Euclidean distance is applied. The experimental results show that the proposed system is efficient enough to identify main objects and reduce the influence of background in the image and hence performance of image retrieval is improved.

Ch. Kavitha et al. [CHK2011] proposed a technique to retrieve images based on addition of the values of Local Histogram and GLCM (Gray Level Co-occurrence Matrix) texture of image sub-blocks to improve the retrieval performance. The image is partitioned into sub blocks having similar size, followed by the computation of color and texture features of each sub-block. The entropy, energy, inverse difference and contrast texture features of GLCM are used for texture feature extraction. A total of 16 texture values were computed per an image sub-block. To compare the query and target image an integrated matching scheme based on Most Similar Highest Priority (MSHP) principle is used and for distance measurement of texture features, the Euclidean distance is adopted.

P.S. Hiremath et al. [PSH2007] presented a novel framework for combining color, texture and shape information and achieved higher retrieval efficiency using image and its complement. The image is divided into non-overlapping tiles of the same size. As local descriptors of color and texture features,
conditional co-occurrence histograms between the image tiles and corresponding complement tiles are used. The local information for two resolutions and two grid layouts is captured that supply different details of the same image. For matching the image, an integrated matching scheme based on MSHP principle and the adjacency matrix of a bipartite graph (created using the tiles of query and target image) is provided. Gradient Vector Flow fields are used for capturing the shape information and Invariant moments are used to record the shape features. The combination of the color and texture features between image and its complement in concurrence with the shape features provide a robust feature set for image retrieval.

Subrahmanyam Murala et al. [SMU2012] proposed a novel image indexing and retrieval algorithm using Local Tetra Patterns (LTrPs) for content-based image retrieval. The standard Local Binary Pattern (LBP) and Local Ternary Pattern (LTP) set the relationship between the referenced pixel and its surrounding neighbours by computing gray-level difference. In the proposed method, the vertical and horizontal directions are calculated using the first-order derivatives in both directions, hence encoding the relationship between the referenced pixel and its neighbours. A generic strategy for computing \( nth \) -order LTrP using \( (n-1)th \)-order horizontal and vertical derivatives for proficient image retrieval system is proposed.

Fig. 2.1 illustrates the calculation of Tetra Pattern Bits, in which the probable local pattern transitions result in an LTrP for direction 1 of the center pixel. The LTrP is coded to 0 when it is equal to the direction of center pixel, otherwise coded in the direction of neighborhood pixel. Similarly, LTrPs are calculated for center pixels having directions 2, 3 and 4.
Fig. 2.2 illustrates the generation of tetra pattern and magnitude pattern. After computing, the second-order LTrP resulted in direction 1 for a center

**Fig. 2.2 Generation of Tetra Pattern and Magnitude Pattern**

Tetra Pattern = 3 0 3 4 0 3 2 0
Pattern1 = 0 0 0 0 0 1 0; Pattern2 = 1 0 1 0 0 1 0 0; Pattern3 = 0 0 0 1 0 0 0 0
Magnitude Pattern = 1 1 1 0 0 1 0 1
pixel marked with red. When first-order derivative is applied in horizontal and vertical directions to the neighborhood pixel 8, they obtained direction 3 and magnitude 9.2. Since the direction of the center pixel and the direction obtained from the neighbourhood pixel are not same, they assigned value 3 to the corresponding bit of the LTrP. It can be observed that the magnitude of the center pixel is 6, which is less than the magnitude of neighbourhood pixel. Hence, the value 1 is assigned to the corresponding bit of the magnitude pattern. After computing the LTrP and the magnitude pattern for the remaining bits of the other seven neighbours in the similar manner, the resulting tetra pattern and the magnitude binary pattern is $3 \ 0 \ 3 \ 4 \ 0 \ 3 \ 2 \ 0$, $1 \ 1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1$ respectively.

The efficacy of the proposed algorithm is analyzed by combining it with the Gabor transform. The proposed system is tested over benchmark image databases viz., Corel 1000 database (DB1), Brodatz texture database (DB2), and MIT VisTex database (DB3) and results obtained are compared with the LBP, the local derivative patterns and the LTP.

S. Liao et al. [SLI2009] presented a novel approach to extract image features for texture classification. The proposed features are robust to image rotation, less sensitive to histogram equalization and noise. It contains two sets of features: Dominant Local Binary Patterns (DLBP) in a texture image and the supplementary features which are extracted by using the circularly symmetric Gabor filter. The dominant local binary pattern method is used for most frequently occurred patterns to capture descriptive textural information, while on the other hand, the Gabor-based features aimed at supplying additional global textural information to the DLBP features. The proposed approach has been intensively evaluated by testing large number of classification to histogram-equalized, randomly rotated and noise corrupted images in Outex, Brodatz, Meastex, and CURET texture image databases. It has been reported that the proposed method achieves the highest classification accuracy in various texture databases and image conditions.
Z. Guo et al. [ZGU2010] proposed a completed modeling of the Local Binary Pattern (LBP) operator and an associated completed LBP (CLBP) scheme for texture classification. A local region is represented by its center pixel and a Local Difference Sign-Magnitude Transform (LDSMT). The center pixels represent the image gray level and which are converted into a binary code, namely CLBP-Center (CLBP_C), with the help of global threshold. By using LDSMT, the image local differences are decomposed into two complementary components: the signs and the magnitudes and two operators, namely CLBP-Sign (CLBP_S) and CLBP-Magnitude (CLBP_M). A significant improvement can be attained for rotation invariant texture classification by combining CLBP_S, CLBP_M, and CLBP_C features into joint or hybrid distributions.

2.5 CONTENT BASED MEDICAL IMAGE RETRIEVAL APPLICATIONS

The use of CBMIR can result in powerful services that can benefit medical information systems. Three large domains can straight away take advantage of CBIR techniques: teaching, research and diagnostics [HMU2004] [RDS2006].

Diagnostic

From the discussion with the doctors, the following situation appears frequently: the doctor visualizes a medical image, he cannot start the diagnosis exactly, he is conscious of the fact that he has seen something similar before but does not have the resources to search for it in the database. This problem can be solved by using CBMIR in which when query image is given as input, the system will provide the similar images from the database. It is very likely that among the retrieved images some relevant information like its diagnosis, observations, and treatment is attached. Therefore, the CBMIR can be directly used in the diagnosis process [JBS2012].

Medical Teaching

There are a series of applications for CBMIR including other ways for access (text-based, hierarchical methods). Students can see the digital medical
images in the database and the attached information in a simple and direct manner. An efficient CBMIR system stimulates learning by comparing similar cases and their particularities or comparing similar cases with different diagnosis which directly provide an aid to students and teachers in the medical field.

**Medical Research**

A proficient CBMIR in the area of research brings up similar advantages as in medical teaching. It can be used, for example, for finding certain types of images to be included in a study, for finding misclassified images, etc. Further CBMIR may be used to remove the sensory and semantic gap present in the digital medical images archive. With the emergence of CBMIR scientists can use mining tools to discover unusual patterns among textual (e.g., treatments reports and patient records) and image content information [WCS2011].

**Clinical Practitioner**

Similarity queries that are based on digital image content descriptors can also help the Clinical Practitioner in diagnostic process [CAK2011]. Clinical Practitioner generally uses similar cases for case-based reasoning in their clinical decision-making process. In this context, while textual data can be used to find images of interest, visual features can be used to retrieve pertinent information for a clinical case.

**Biodiversity Information Systems**

In the field of Biology, Biologists collect many kinds of data for biodiversity studies, including spatial data and images of living beings. In an ideal world, CBMIR applications can be used in Biodiversity Information Systems (BIS) that should help researchers to enhance or complete their knowledge and understanding about species and their habitats by combining textual, content-based image and geographical queries [JDA2008]. A typical query example start by providing an image as input like a photo of a shark and then demand from the system to “Retrieve all database images containing shark whose fins are shaped like those of the shark in this photo”.
**Digital Libraries**

There are several digital libraries around the world that support services based on image content [JIN2010] e.g. There is a comprehensive digital collection of Taiwan’s butterflies to provide a modern research environment on butterflies for academic institutions, as well as an interactive butterfly educational environment for the general public [JHO2000]. This digital museum emphasizes on the ease to use, and provides a number of innovative features to help the user fully utilize the information provided by the system. Therefore for efficient collection and retrieval of digital images in particular domain specified in the digital library, CBMIR may play a significant role.