CHAPTER 3

RELATED WORK

Image Retrieval has always been an area of extensive research. Many efficient retrieval algorithms have already been proposed in this thesis. In this section we categorized the works pertaining to content based retrieval based on the methods adopted for the process. This chapter explains the works done earlier in CBIR.

3.1 CBIR RETRIEVAL SYSTEMS

Works using genetic programming framework for web based CBIR retrieval system like SPIRS (Spine Pathology & Image Retrieval System) permits exploration of a large biomedical database of digitized spine X-ray images using a combination of visual and textual queries with exploration of similarity functions (William et al. 2009). Here nonlinear image similarities are combined and validated through several experiments with shape similarities of objects (Torres et al. 2009). The combination is done with the help of multiple feature vectors in order to improve user expectations. The models were trained using set of positive and negative sample images, with no manual extraction of significant objects or features (Schmid et al. 2001).

A novel relevance feedback algorithm for content-based image retrieval using Proximal Support Vector Machine (PSVM) is presented. PSVM seeks to find the optimal separation of hyper planes comprising positive and negative proximal planes. The proximal vectors on the proximal
planes among training samples uses the distance from the positive proximal
plane as a measure of image dissimilarity. The computational time for
relevance feedback is thereby reduced, from pre-computed dissimilarity
matrix (YoungSik & JiSung 2004).

The images were exploited in different contexts, ranging from
history of art, through medicine, to education (Jurgen et al. 2002). In general,
existing querying paradigms are based either on the usage of textual strings,
for high-level semantic queries or on 2D visual examples for the expression
of perceptual queries. Semantic queries require manual annotation of the
database images. Instead, perceptual queries only require that image analysis
is performed on the database images in order to extract salient perceptual
features that are matched with those of the example. However, usage of 2D
examples is generally inadequate as effective authoring of query images,
attaining a realistic reproduction of complex scenes, needs manual editing and
sketching ability. Investigation of new querying paradigms is therefore an
important and marginally investigated factor for the success. A novel
querying paradigm is presented by the authors based on usage of 3D
interfaces exploiting navigation in virtual environments. The analysis has led
to the development on user test retrieval efficiency and effectiveness, as well
as on an evaluation of users’ satisfaction.

Image retrieval framework were successful with adopting rules,
color and texture features, Co-Occurrence Matrix (CCM) and Difference
Between Pixels of Scan Pattern (DBPSP) are successful for image retrieval
schemes. Such predominant features are used for image mining for
knowledge acquisition. Irrelevant images are identified through clustering
model. Pruning is used to reduce the dimensionality of the extracted features.
Experiments of the proposed model achieve a very good performance in terms
of the average precision, recall and retrieval time compared with other models
(ElAlami et al. 2011). Image indexing and retrieval identifies relative positions of the image regions. The segmentation of the image is carried out using fuzzification. Works using relevance feedback aiming at interactively leading the search for systems like Fuzzy Region-Based Image Retrieval (FReBIR). Several other systems were also successful (Sylvie et al. 2009).

Content Based Image Retrieval (CBIR) is more efficient than text based image retrieval by incorporating visual attention (Satrajit & Vimala 2012). Several works have been reported for CBIR with novel fuzzy relevance feedback framework. Conventional relevance feedback requires crisp decisions to be made on the relevance of the retrieved images. Integrating user’s fuzzy perception of visual contents into the framework of relevance feedback is promising with the experiments analysis showing the effectiveness using 10000 images (KimHui et al. 2005).

Relevance feedback mechanism as a powerful technique for content-based image retrieval (Hossein et al. 2009). They have used many parameter estimation approaches, most of them utilizing information of the relevant retrieved images or have not made great use of information of the irrelevant retrieved images. The work presents by them adopts a novel approach to update the inter-weights of integrated probability function by using the information of both relevant and irrelevant retrieved images. The results were effective and robust especially in the situation where there is no relevant retrieved images.

A new content based image retrieval system with image retrieval refinement based on relevance feedback (MIRROR), is developed for evaluating MPEG-7 visual descriptors. The dominant color descriptor similarity measure and relevance feedback are also developed for the proposed system and several MPEG-7 visual descriptors are adopted in MIRROR for performance comparison (KaMan et al. 2005).
3.2 FEATURE BASED SCHEMES

Some works relating to features in the retrieval process is explained in this subsection. A novel image feature representation method, namely Color Difference Histograms (CDH), for image retrieval is investigated (Guang Hai & Jing Yu 2013). Here the work differs from other by histograms, which are mere count of the number or frequency of pixels. CDH’s intercepts the perceptual color difference under different backgrounds with regard to colors and edge orientations in color space. This proposed method pays more attention to color, edge orientation and perceptually uniform color differences and encodes color, orientation and perceptually uniform color difference via feature representation. Color histogram and texture features are best design for constructing weights of feature vectors. The retrieval experiments show that the fused features retrieval brings better results than the single feature retrieval (Jun et al. 2011).

Content based image retrieval based on colour, texture and shape features for biometric security are three main considerations in identifying the moment invariants. In general three distinct features of the image and similarity metrics were based on Euclidean measure. Histogram extracts the colour features of an image, Gabor filter extracts the texture features and moment invariant extracts the shape features of an image (Kashif et al. 2012). Combining all the three i.e. color, texture and shape information is found to have higher retrieval efficiency. The steps involve quantizing the image for color feature. Secondly, steerable filter decomposition is done to extract texture features and finally pseudo zernike moments of an image are captured for shape extraction. The combination of the color, texture and shape features is noted to have more accurate and efficient results in retrieving the user interested images (XiangYang et al. 2011).
Feature selection technique aims at selecting the optimal features that not only maximize the detection rate but also simplify the computation of the image retrieval process (ElAlami et al. 2011). Predominantly 3D color histogram, gabor filter were used along with Genetic Algorithm (GA) for replacing numerical features with nominal features. Most research reports of CBIR analyses different features to maximize the computation of image retrieval. The study integrates conventional pattern Co-Occurrence Matrix (CCM), Difference Between PIXEELS of Scan Pattern (DBPSP) and color histogram for K-mean (CHKM) to facilitate image retrieval. Besides, based on the image retrieval system (CTCHIRS), a series of analyses and comparisons were performed with three image databases and different properties to carry out feature selection (Chuen et al. 2009).

The areas of image processing and pattern recognition used standard statistical techniques to estimate the relative importance based on the concept of RGB color correlation index between images. The study sample included 1000 images from database constituted for the study. The image with maximum RGB color correlation index yields relevance image (Parichat et al. 2011). Features found for image retrieval are classified using K-means algorithm into several clusters according to their colors. By measuring the spatial distance among the pixels in a cluster, the three types of Color Spatial Distribution (CSD) features of the image could be obtained (Chuen et al. 2011).

These clustering tasks could be used effectively for retrieving more similar images from large digital image databases. In this context, a novel Integrated Curvelet based image retrieval scheme has been proposed (Youssef et al. 2012). The proposed model integrates curvelet multiscale
ridgelets with Region based vector codebook sub band clustering (RBSC). An integrated matching scheme, based on most similar Highest Priority (MSHP) principle, is used to compare the query and target images yielding higher average precision with higher precision recall crossover point values. Using euclidean distance and chi-square distance have potential significance in feature based retrieval schemes (Priyanka et al. 2011).

Due to the potential significance of content base image retrieval, the importance of research field has been tremendously witnessed in many CBIR applications. CBIR applications have currently been a relevant research field in computer science with the management of multimedia databases. Though color and texture are used as basic features to describe images, binary tree structure could be used to describe higher level features of an image. This enables to keep the information about separate segments of the images. The performance of the proposed scheme is compared with the SIMPLIcity system using COREL image database (Zahra & Mansour 2009).

Two related key issues are achieving an efficient content-based retrieval and a fast response time. Relevance feedback is a powerful tool to improve the retrieval results of the CBIR systems (some works presented in section 3.3). Traditional relevance feedback searches only a small feature subspace as compared with the entire huge feature space. Also feedback scheme based on multi-features classification is also essential in this context. To develop such a scheme, a new effective texture feature and efficient dissimilarity measure is identified with large datasets (XueLong et al. 2002).

Methods based on an efficient combination of multi resolution color and texture features were investigated. Color autocorrelograms of the
hue and saturation component images in HSV color space are integrated with basic colour components. The color and texture features are extracted in multiresolution wavelet domain and later combined together (Young et al. 2008).

Feature extraction and the use of the features as query terms is very crucial in Content Based image Retrieval (CBIR) systems. Here again color, texture and shape extraction methods are dealt that uses Gabor filtration for determining the number of Regions Of Interest (ROIs), in which fast and effective feature extraction is performed. In ROIs extracted, texture features based on threshold Gabor features, color features based on histograms, color moments in YUV space, and shape features based on Zernike moments are then calculated. The features presented proved to be efficient in determining similarity between images (Choras et al. 2007).

Works combining textual and content based approaches are used in retrieving relevant medical images. For content based approach four image features and for text based approach, word expansion are developed to accomplish the retrieval tasks (PeiChen et al. 2006). Experimental results proved that combining both these approaches is better than using one approach. Support Vector Machines (SVM) is used in automatic annotation to learn image feature characteristics which assists in image classification task. Seamless combination of two complementary approaches namely color clustering method and acquiring image regions inevitably contain many errors. An effective image indexing scheme is also facilitated for fast and efficient image matching and retrieval (Yihong Gong et al. 1999).
3.3 RELEVANCE FEEDBACK MECHANISM

Relevance feedback mechanisms are of greater importance for finding feature representations of images in databases to enable content based image retrieval (CBIR). Significant time and effort have been spent by several researchers for improving retrieval precision over time which is presented in this subsection. The concept of relevance feedback lies in refining retrieval iterations. This would allow us to infer the unseen images the user would not likely desire. (MacArthur et al. 2000). With high level semantic retrieval process, search engines are utilized to retrieve a large number of images using a given text-based query. At a lower level, image retrieval process similar image search function is used for updating the input query for image similarity. Both high level and low level features attempts integrates joint querying and relevance feedback scheme.

Relevance Feedback (RF) schemes based on Support Vector Machines (SVMs) have been widely used in Content-Based Image Retrieval (CBIR). However, the performance of SVM-based RF approaches is often poor when the number of labeled feedback samples is small. This is mainly due to 1) the SVM classifier being unstable for small-size training sets because its optimal hyper plane is too sensitive to the training examples; and 2) the kernel method being ineffective because the feature dimension is much greater than the size of the training samples. Hence a new machine learning technique, multitraining SVM (MTSVM) combining the merits of the cotraining technique and a random sampling method in the feature space. Based on the proposed MTSVM algorithm, the above two problems can be mitigated. Experiments are carried out on a large image set of some 20 000 images, and the preliminary results demonstrate that the developed method consistently improves the performance over conventional SVM-based RFs in
terms of precision and standard deviation, which are used to evaluate the effectiveness and robustness of a RF algorithm, respectively (Jing et al. 2006).

Two of the most successful, fast and efficient color feature extraction namely Auto Color Correlogram and Correlation (ACCC) based on Color Correlogram (CC) and Autocorrelogram (AC) algorithms were used for extracting and indexing low level features of images (Wichian et al. 2010). To incorporate an image analysis algorithm into the text-based image search engines without degrading their response time, multi threaded processing framework is proposed.

A new means of finding pictures in large repositories without using any other information except the own content of the images, usually with feature vectors extracted from low level descriptors. Algorithms combining relevance feedback, evolutionary computation and distance based learning attempts to reduce the existing gap between the high level semantic content of the images and the information provided by their low level descriptors (Arevalillo et al. 2011). In particular, a framework which is independent from the particular features used is presented in the proposed work. Content based image retrieval (CBIR) is the mainstay of image retrieval systems.

Recent works has drawn attention in identifying profitable relevance feedback techniques for obtaining precise results. Existing relevance feedback based methods requests a number of iterative feedbacks for refining search results, especially in a large scale image database. A novel method named Navigation-Pattern-based Relevance Feedback (NPRF) is proposed to achieve high efficiency and effectiveness of CBIR (JaHwung et al. 2010). In order to improve efficiency, the iterations of feedback could
be reduced substantially by using the navigation patterns discovered from query log. The authors have proposed NPRFSearch algorithm to discover navigation patterns with three kinds of query refinement strategies namely Query Point Movement (QPM), Query Reweighting (QR) and Query Expansion (QEX).

Concepts incorporating high level and low level features with user's feedback not only assign proper weights, but also dynamically select large collection of parameters. The aim lies in identifying a set of relevant features according to a user query while at the same time maintaining a small sized feature vector to attain better matching and lower complexity. The feature adaptation is usually based on a hierarchical approach. The weights are then adjusted based on previously retrieved relevant and irrelevant images without further user feedback (Anelia et al. 2007).

Some of the works reported in CBIR, based on visual signature has attracted more attention in recent research in content based image retrieval. Image segmentation is a critical process in image shape description. Unfortunately, it has been demonstrated that accurate image segmentation is still an open problem (Dewen & Shoujue 2010). There are still many shortcomings for image retrieval system due to low level visual features, semantic gap and user feedback. Through the user's feedback, high level semantic is obtained based on machine learning theory. Combining the retrieval results with relevance feedback technology, image feature dimensional reduction using the linear discriminant analysis reduces the semantic gap, there off to improve the retrieval efficiency and performance.

A new Relevance Feedback (RF) methodology for content based image retrieval (CBIR) is presented. This methodology is based on Gaussian
Mixture (GM) models for images. According to this methodology, the GM model of the query is updated in a probabilistic manner based on the GM models of the relevant images, whose relevance degree (positive or negative) is provided by the user. This methodology uses a recently proposed distance metric between probability density functions (PDFs) that can be computed in closed form for GM models (Apostolos et al. 2006).

3.4 SIMILARITY & DISSIMILARITY FOR CBIR

Identifying relevance of a image is done by similarity or dissimilarity. Dissimilarity measurement plays a crucial role in content based image retrieval, where data objects and queries are represented as vectors in high dimensional content feature spaces. A core set of dissimilarity measures were presented to classify them into three categories. Then a systematic performance comparison is carried out to test the effectiveness of these dissimilarity measures with six different feature spaces and some of their combinations on the Corel image collection (Haiming et al. 2008).

Dissimilarity measurement in content-based image retrieval, where data objects and queries are represented as vectors in high-dimensional content feature spaces. The authors have summarized fourteen core dissimilarity measures and classified them into three categories. A systematic performance comparison is carried out to test the effectiveness of these dissimilarity measures with six different feature spaces and some of their combinations on the Corel image collection. From our experimental results, it is inferred that a number of observations and insights on dissimilarity measurement in content-based image retrieval would lay a foundation for developing more effective image search technologies (Haiming et al. 2008).
Similarity measure plays a critical role in obtaining a high performance content based image retrieval (CBIR) system. Given a pair of images, existing similarity measures aims at identifying a static and constant similarity score. However, an image can usually be perceived with different meanings and therefore, the similarity between the same pair of images may change when the concept being queried changes. This work proposes a query sensitive similarity measure, Qsim, which takes the concept being queried into account in measuring image similarities, by exploiting the query image as well as the images labeled by user in the relevance feedback process (Zhihua et al 2006).

Content based image retrieval (CBIR) has been more important in the last decade, and there exists a gap between high level semantic concepts and low level visual features which hinders performance improvement. This is sorted out using online feature selection. Investigating online feature selection in the relevance feedback learning process improves the retrieval performance of the region-based image retrieval system (Wei et al. 2006). The authors proposed model has contributions in three fold areas. First, a novel feature selection criterion is proposed, which is based on the psychological similarity between the positive and negative training sets. Second, an effective online feature selection algorithm is implemented in a boosting manner to select the most representative features for the current query concept and combine classifiers constructed over the selected features to retrieve images. Third, a novel region based representation is described for images to create a uniform feature space with real valued fuzzy features.

Content based retrieval systems faces a major problem of retrieving similar images which is a challenging task. Aiming at high retrieval performance, these retrieval systems capture the user’s notion of similarity
through expressive image models and adaptive similarity measures. The evaluated metric tries to approximate the individual user dependent notion of similarity as close as possible. Similarity measures are robust and measures the individual quality changes in order to maintain high retrieval performance. In order to evaluate the robustness of similarity measures, the general concept of the stability of a similarity measure with respect to query modifying transformations is described (Christian and Thomas, 2012). The results investigated on adaptive similarity measures based on different benchmark image databases proved promising results.

A novel probabilistic framework to process multiple sample queries in Content Based Image Retrieval (CBIR) framework will be interesting. Such independent system measures the distance or (dis)similarity measures which support the retrieval system. It assumes mutual independence among their outcomes and gives rise to a relevance feedback mechanism in which positive and negative data are combined in order to optimally retrieve images according to the available information. Users interactively supply feedback and iteratively retrieve images is set both to model the system and to perform some objective performance measures. Several repositories with different image descriptors and corresponding similarity measures have been considered for benchmarking purposes. The results have been compared to those obtained with other representative strategies, suggesting that a significant improvement in performance can be obtained (Miguel et al. 2010).

3.5 QUERY PROCESSING AND RETRIEVAL

From a perceptual standpoint, the subjectivity inherent in understanding and interpreting visual content in multimedia indexing and retrieval motivates the need for online interactive learning (Kushki et al.
Efficiency and speed are considered to be most important factors in interactive visual content retrieval. The current approaches impose restrictive assumptions on similarity calculation and learning algorithms. Specifically, content-based image retrieval techniques generally assume that perceptually similar images are situated close to each other within a connected region of a given space of visual features. This proposed method for interactive image retrieval using query feedback is promising. Query feedback allows us to learn the user query as well as the correspondence between high-level user concepts and their low-level machine representation by performing retrievals according to multiple queries supplied by the user during the course of a retrieval session. The results demonstrated that this algorithm provides accurate retrieval results with acceptable interaction speed compared to existing methods.

An approximate query processing approach for a content-based image retrieval method based on probabilistic relaxation labeling is proposed. The novelty lies in the inclusion of a filtering mechanism based on a quasi lower bound on distance in the vector space that effectively spares the matching between the query and a number of database images from going through the expensive step of iterative updating the labeling probabilities (Kwan et al. 2003). The work resembles the two-step filter-and-refine query processing approach that has been applied to k-nearest neighbor (k-NN) retrieval in database research. It is confirmed by experiments that the proposed approach consistently returns a close approximation of the accurate result, in the sense of the first ‘k’ in the top k output of a k-NN search, while simultaneously reduces the amount of processing required.

Visual query processing is one of the new issues for content-based image retrieval. Earlier works proposed a new local membership function,
which preserves the relationships between the input feature vectors of the
images and their neighboring weight vectors (Zhiwen et al. 2012). The
feature vector of the query image is mapped and visualized in the 2D grid as
well. The users not only can visualize the locations of the query image and the
image data in the database. Then the users retrieve the candidates from the 2D
grid interactively through visual query processing in the filter phase. Finally,
the query results are obtained from the candidates by performing similarity
ranking in the original feature space during the refinement phase.

The revolutionary internet and digital technologies have imposed a
need to have a system to organize abundantly available digital images for
easy categorization and retrieval. CBIR systems have attracted many
researchers of information technology giants and leading academic
institutions for development of CBIR techniques. In a high level semantic
retrieval process, search engine are employed to retrieve a large number of
images using a given text-based query (Jayaprabha et al. 2012). In a low level
image retrieval process, the system provides a similar image search function
for the user to update the input query for image similarity characterization.
These techniques encompass diversified areas, viz. image segmentation,
image feature extraction, representation, mapping of features to semantics,
storage and indexing, image similarity distance measurement and retrieval
making CBIR system development a challenging task.