CHAPTER 1
INTRODUCTION

1.1 CONTENT BASED IMAGE RETRIEVAL

Content Based Image Retrieval (CBIR) is a technique used for extracting similar images from an image database. Content Based means search analysis based on the contents of an image. Content refers to the color, texture, shape or any other information. The feature descriptors of the content can be obtained from the image itself. All CBIR systems perform search and retrieval operations in image database using image features like color, texture and shape. In this research work, Image retrieval is performed by extracting information related to color, texture, shape and pattern generation features (Quellec 2012). Earlier, this retrieval system was not able to achieve satisfactory retrieval performance. This was mainly due to semantic gap between the low level visual features (color, texture, shape and pattern) and the high level human perception. In order to reduce the gap, the interactive RF is introduced in CBIR. The basic idea behind RF is to incorporate human perception subjectivity into the query process and provide users with an opportunity to evaluate the retrieved results. The RF mechanism has significantly improved the retrieval performance.

Initially, pre-processing is done over the image for noise reduction. Wavelet based fuzzy filter suppresses the additive noise thereby improving the image quality. The image information obtained from color or texture or shape or pattern feature is not sufficiently robust for accurately describing the
image content. The aim of this research was to integrate these distinct features of the image to produce better results across various datasets. Color is one of the most widely used features in CBIR (Chen 2005). It is not capable of changing to the size and the orientation of the image. Color can be represented by feature descriptors such as color spaces, color histogram and color moments. In this retrieval process, mean, variance and skewness of the statistical values of the input image forms the color feature vector. Texture refers to the natural surface properties of an object and their relationship to the surrounding environment. Each texture image is described by a feature vector after applying fuzzy texture spectrum. Shape is a feature that represents the contour of an object in an image. Shape feature can be obtained using canny edge operator. Finally, pattern feature is generated. During retrieval, Euclidean distance measures the similarity of the query image and images in the benchmark database in various dimensions such as color, texture, shape and pattern, to retrieve images which are similar. After obtaining some relevant images, the user evaluates the retrieved images more or less relevant to the query one. By using RF technique the system updates the queries so as to place more weight on relevant element and less on irrelevant one. This RF search process is repeated until similar images are retrieved.

1.2 A CONCEPTURAL FRAMEWORK FOR CBIR

CBIR uses the contents of images to represent the images and retrieve relevant images from the image datasets. CBIR is the application of computer vision (Liu et al 2012). It solves the image retrieval problem for searching of digital images in large databases. A typical CBIR system is divided into off-line feature extraction and on-line image retrieval. A conceptual framework for CBIR is illustrated in Figure 1.1. A visual content descriptor represents the visual features of the whole image. In off-line stage, the system automatically extracts visual attributes (color,
shape, texture, and pattern information) of each image in the database based on its pixel values and stores them in a different database within the system called a feature database. The feature data (also known as image signature) for each of the visual attributes of each image is very much smaller in size compared to the image data, thus the feature database contains an abstraction (compact form) of the images in the image database (Murala et al 2012). One advantage of an image signature over the original pixel values is the significant compression of image representation. However, a more important reason for using the image signature is to gain an improved correlation between image representation and visual semantics. In on-line image retrieval, the user can submit a query example to the retrieval system in search of the desired images (Gavrielides et al 2006). The distances (i.e., similarities) between the feature vectors of the query image and feature database are then computed and ranked. Retrieval is conducted by applying an indexing scheme to provide an efficient way of searching the image database. Finally, the system ranks the search results and then returns the results that are most similar to the query examples. If the user is not satisfied with the search results, the CBIR system provides RF to the retrieval system (Liu et al 2007).
Feature extraction extracts features from an image. Feature extraction of the image in the database is typically conducted offline, so computation complexity is not a significant issue (Iqbal et al 2012).

Figure 1.1 A conceptual framework for CBIR
1.2.1 Filtering Technique for Noise Removal

Digital "noise" is a common problem in digital cameras today. A lot of factors can introduce noise to digital photography, but there are certain steps that can be taken to avoid it. In a digital camera, if the light which enters the lens misaligns with the sensors, it creates image noise (Zhan et al 2009). Even if noise is not so obviously visible in a picture, some kind of image noise is bound to exist. There are many kinds of filters used to remove the noise such as linear smoothing filter, median filter, wiener filter and wavelet based fuzzy filter.

1.2.2 Color Feature

Color is the most extensively used visual content for image retrieval. It has three dimensional values that make its discrimination potentially superior to the one dimensional gray values of images. A computer may describe a color using the amounts of red, green and blue phosphor emission required to match a color. It can be classified into device dependent and device independent types. A device dependent color space is a color space where the color produced depends on the equipment used for display. A device independent color space is one where a set of parameters produce the same color on whatever equipment they are used.

Before selecting an appropriate color description, color space must be determined. A color space is a method by which color can be specified, created and visualized. In humans, the color may be defined by its attributes of brightness, hue and colorfulness (Yang et al 2011). The color representation is shown in table 1.1.
The purpose of a color model is to facilitate the specification of colors in some generally accepted way (Klaric et al 2012). There are many different color spaces available, which may be beneficial in different application domains. The color representations most commonly used in electronic systems are RGB, CIE-XYZ, CIE-Lab, CIE-Luv, YCbCr and so on. CIE-XYZ, CIE-Lab and CIE-Luv are designed to match human perception. Lab model is a three dimensional model. The first parameter of the Lab is extremely intuitive: changing its value is like changing the brightness setting in a TV set (Mohmoud Mejdoub et al 2009). Therefore only a few representations of some horizontal "slices" in the model are enough to conceptually visualize the whole gamut, assuming that the luminance would be represented on the vertical axis. It is represented by the combination of chrominance and luminance. Y is the Luminance component and \( C_b \) and \( C_r \) are the blue-difference and red-difference Chroma components (Mukherjee & Mitra 2008).

**Table 1.1 Color representations**

<table>
<thead>
<tr>
<th>Color space</th>
<th>Chosen for</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGB</td>
<td>Widespread use (Mignotte 2008)</td>
</tr>
<tr>
<td>CIE-XYZ (Mignotte 2010)</td>
<td>Role as the basis for CIE-Lab and CIE-Luv</td>
</tr>
<tr>
<td>CIE-Lab</td>
<td>Perceptual relevance (Mejdoub et al 2009)</td>
</tr>
<tr>
<td>CIE-Luv</td>
<td>Perceptual relevance (Mojsilovic &amp; Soljanin 2001)</td>
</tr>
<tr>
<td>YCbCr</td>
<td>Simplicity and explicit separation of luminance and chrominance components (Bunte et al 2011).</td>
</tr>
</tbody>
</table>
Color moments are used to represent the color distributions of images for image retrieval application. It can differentiate images based on their features of color. Here three color moments such as first order (mean), second order (Variance) and third order (skewness) could be used for color representations (Abdullah-Al-Wadud et al 2007). It can be calculated for each of the channels in an image.

1.2.3 Texture Feature

Texture is a powerful regional descriptor that helps in the retrieval process (Lai & Chen 2011). The major task in texture analysis is to partition the image space into a set of sub regions, each of which is homogeneously textured. Texture image is characterized by its texture spectrum. It describes the distribution of all the texture units within the image. It can be used to classify and recognize objects and can also be used in finding similarities between images in multimedia databases.

1.2.4 Shape Feature

Shape may be defined as the characteristic peripheral configuration of an object. It can be an outline or a contour. It permits an object to be distinguished from its surroundings by its outline boundary (Chen et al 2011). Shape representations can be generally divided into two categories: Global Features or Boundary-based and Local Features or Region-based. Boundary-based shape representation uses only the outer boundary of the shape. This is done by describing the region i.e., the pixels along the object boundary. Region-based shape representation uses the entire shape region by describing the considered region using its internal characteristics (Wang & Ye 2005). In this research work, edge histogram of an image is obtained by using canny operator.
1.2.5 Pattern Generation

To achieve pattern feature extraction, different iterations can be done for a different window size \((2N+1)^*(2N+1)\). During the first iteration a 3x3 window around a central pixel (i.e. \(N=1\)) is used. Some additional (recursive) iterations are performed that are quite similar to the first iteration. Each iteration uses the modified image of the previous iteration and a different window. A window of pixels (including the center) is considered during pattern generation.

1.2.6 Relevance Feedback

RF is one of the powerful methods, to narrow down the semantic gap and to improve the performance of a CBIR system. RF focuses on the interactions between a user and the search engine by requiring the user to label semantically similar or dissimilar images with the query image. In this research work RF techniques have been proposed to involve the user in the loop to enhance the performance of CBIR (Aggarwal et al 2002).

It performs the following: (1) to fill the gap between low level features and high level visual concepts, and (2) to use the subjectivity of the human perception of images, against a limited number of retrieved images (typically 15) (3) to improve the search process.

1.3 OBJECTIVE OF THE THESIS

The main highlights of this research are as follows: i) the low level image features such as color features from the color spaces (HSV, Lab and \(YCbCr\)), texture spectrum, edge histogram and patterns are adopted in this retrieval approach ii) RF is incorporated to improve the performance of image retrieval.
1.4 ORGANIZATION OF THE THESIS

The rest of the thesis is organized as follows.

Chapter 2 summarizes the literature survey of preprocessing, color image segmentation, color-texture image segmentation, color, texture, shape and pattern based image retrieval, similarity measure and RF of image retrieval.

In Chapter 3 preprocessing is discussed. It concentrates on removal of additive noise, through the process of wavelet based fuzzy filter, to enhance the quality of the image.

In Chapter 4, the Color Image Segmentation based on Improved Adaptive Kernelized Fuzzy C Means clustering (IAKFCM) is discussed. The fusion of different segmented color spaces are discussed and compared with K-means method.

Color-Texture Segmentation using IAKFCM-EMD is discussed in chapter 5.

Color, texture, shape and pattern features based retrieval systems are introduced in Chapter 6. Euclidean distance is used to find the distance between the query image and the images in the database. RF is applied that shows the step by step enhancement during the retrieval process. Experimental results and evaluation of the image retrieval for different databases are also discussed.

Finally, Chapter 7 provides the conclusion of the present study and also provides possible suggestions for future work.