Chapter 1

Introduction

1.1 Motivation for the Research

Traditional image retrieval approach is based on manual image indexing where human indexers assign keywords to images. Relevant images can be retrieved by using the indexed keywords as queries. However, there are limitations of manual indexing. For example, it is very time consuming and expensive, especially when the size of the image collection is very large. In addition, different indexers may assign different keywords to the same image, or even the same indexers perform differently at various circumstances and times. For retrieval, users may not be aware of or agree with the indexed keywords or terms, making the retrieval results unsatisfactory. Advances in computer and multimedia technologies allow the production of digital images and large repositories of images. Therefore, designing automated image retrieval systems which can operate on a large scale is necessary. The goal is to create, manage, and query image databases in an efficient and effective manner.

Content Based Image Retrieval (CBIR) also known as query by image content is the application of computer vision to the image retrieval problem i.e. the problem of searching of digital images in large databases. CBIR, proposed in the early 1990s, is a technique to automatically index images by extracting their (low-level) visual features, such as color, texture, and shape, and the retrieval of images is based solely upon the indexed image features. Typically, images are represented as points in a high dimensional feature space. Then, a metric is used to measure dis/similarity between images on this space. Images similar to the query are retrieved.
CHAPTER 1. INTRODUCTION

1.2 The Aim and Objectives
The aim of this research work is to develop a Content Based Image Retrieval System based on the spatial layout of the color content of an image. For example, a colored image can be viewed as a distribution of colored pixels in a 2-D plane which is basically a projection of a 3D object. This distribution of colored pixels forms color clusters of arbitrary shape within the image. A color cluster can be viewed as a data set having a color and a position. An image is usually formed by a number of constituent objects. Each such object can be characterized by a single color cluster or a combination of several color clusters. Figure 1.1 shows an image with four color clusters marked by cluster numbers 1, 2, 3 and 4. In addition there are five distinct objects, viz., a tree constituted of cluster numbers 1 and 2, the background constituted of cluster number 3, the earth constituted of cluster number 4, the leaf constituted of cluster number 1 and the trunk of the tree constituted of cluster number 2. An index for the image can be automatically generated based on the above clusters and objects.

![Figure 1.1. An example image having four clusters](image)

The objectives of this research are as follows:

- Develop a fast clustering technique that can extract color clusters of any shape.
- Develop a prototype to identify the important color clusters or objects of an image.
- Develop a translation, scale and rotation invariant index for each objects or clusters identified. The dimensionality of the index has to be kept as small as it can be for an Image such that no dimensionality reduction module is necessary.
- Develop a index structure which will facilitate quicker search operation and
- Develop a matching engine for similarity search.

1.3 The Hypothesis and Novelty of the Work
1.3.1 The Hypothesis
The main hypothesis is to claim that proper segmentation of the color features of an image will help in identifying objects underlying the image. Once the color segments and the objects present
in the image are identified, they can be indexed based on the spatial layout. When the image can be indexed by some indexing structure, searching will become easier.

1.3.2 The Originality of the Work
The originality of this thesis is the introduction of a new image segmentation/clustering approach (BOO-Clustering) of distribution of colored pixels within an image. Objects are identified from the color clusters present in the image by retaining only the interesting ones based on the percentage frequency of occurrence dynamically. Silhouette moments of second order are used for index calculation of the objects. These indices are stored in a variant of B-tree structure for indexing purpose. Appropriate matching engine has been devised for similarity retrieval of images.

1.4 Scope of our work
Our method of indexing and retrieval of images takes query by example approach i.e. an input query image is submitted to the system for index generation and retrieval process. The system generates all color clusters and all combinations of color clusters (that form the objects) present in the image automatically and silhouette moments are calculated. These set of silhouette moments are used for indexing and retrieval.

Occlusion, minimal difference in background and foreground colors as well as angle in which an image is acquired may lead to drastic change in shape of objects in the image. Under such circumstances silhouette moments based on color clusters may be inadequate for indexing and retrieval. Human computer interaction (HCI) may be necessary to gather knowledge about objects in the image. This requires further investigation and is beyond the scope of this thesis.

Image Database used for the experiments
As discussed in Scheme I and II, for our experiments we have used Cohn-Kanade Facial Expressions and other real world and synthetic image databases. They include facial expressions, scenery, animals, cars, flowers etc. For example, the facial expression database consists of nearly 5000 images of different persons and for each person there are nearly 30 different photographs having different facial expressions. All these images have been taken at a particular direction (facing directly) and at a fixed distance from the camera having the same background color. These facial images are of same aspect ratio. We have analyzed our proposals using standard measures of image retrieval viz. precision and recall (Section 2.5).
CHAPTER 1. INTRODUCTION

1.5 Thesis Outline

The reminder of this thesis is organized as follows:

Chapter 2 surveys the state-of-the-art image retrieval (CBIR) techniques and some Content Based Image Retrieval systems which are currently in use.

Chapter 3 reports the background and related concepts of the work.

Chapter 4 reports some segmentation/clustering algorithms currently in use.

Chapter 5 presents a clustering algorithm.

Chapter 6 presents the scheme I architecture and its retrieval performances.

Chapter 7 reports an enhanced version of scheme I reported in the preceding two chapters.

Chapter 8 gives the concluding remarks and also shows the future research direction.