A New Approach for Exploration of Image Databases

Daniela Stan

Intelligent Information Engineering Laboratory

Department of Computer Science & Engineering

Oakland University

Rochester, Michigan 48309-4478

Phone: (248) 370-2137

Fax: (248) 370-4625

dstan@oakland.edu

Abstract

The goal of this paper is to describe an exploration system for large image databases. The system also gives the capability for semi-automatic annotation: instead of trying to give all possible meanings to an image, the user will interpret and annotate an image in the context in which that image appears, thus dramatically reducing the time taken to annotate large collection of images.

Keywords: k-means clustering, multi-dimensional scaling, image annotation

1. INTRODUCTION

The increasing rate at which images are generated in many application areas gives rise to the need of image retrieval systems to provide an effective and efficient access to image databases, based on their visual content [1]. There are two main approaches to access an image database: a query driven methodology allows the user to specify either a text query (keywords, annotations, etc) or an image query; a browsing driven methodology allows users to navigate through the database until they identify an image of interest and then, initiate a search using that image as the query image.

Our approach is meant to generate visualization of an image database from finer to finer details and to help the user understand the database as a whole. To understand better our approach, imagine discovering a particular topic in a book with minimum reading: you read the table of content and if you are interested in a particular chapter, you read the titles' sections of the corresponding chapter and so on until you find the pages containing the information that you want to read. The same modality of exploration we want to create for an image database having thousands or millions of items: in our case, the table of content will

give a general view of the image database and will consist of the most representative images, referred as *electronic* IDentification (*e*ID) images.

2. THE PROPOSED SYSTEM DESCRIPTION

We propose the system shown in Fig. 1.

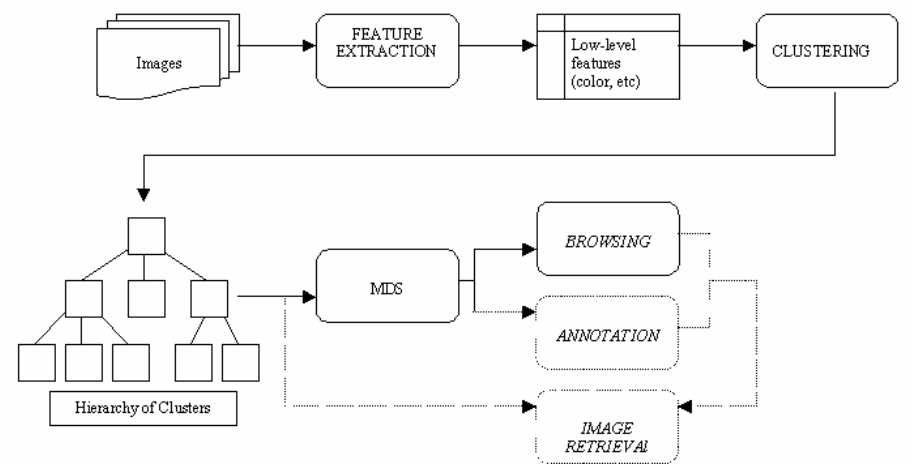

Figure 1: The diagram of *e*ID system. The dashed lines represent extended functionalities integrated into our system.

The first stage is the feature extraction stage in which images are represented in a way that allows efficient storage and retrieval results that correspond to the human perception. We use color information [2] to represent the images; every image is partitioned in 8 by 8 blocks and three histograms (for hue (H), saturation (S) and value (V)) are calculated for every block (Fig. 2). The location of the area peak for every histogram gives the hue, saturation and value representation of the corresponding block.

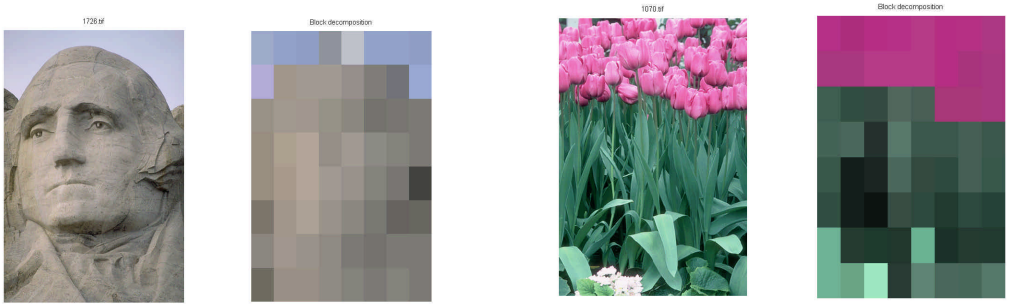

Figure 2: Two examples of color images and their color-block representation

At the second stage we build the hierarchy of clusters; we use an adaptation of k-means clustering technique [3] as an effective indexing module that solves both high dimensionality and non-Euclidean nature of (H,S,V) color feature spaces. At the third stage we choose to use the Multi-Dimensional Scaling (MDS) [4] to visualize the image database. The reason for using the MDS approach is that we want to provide the user with a global view of the image database (Fig.3) and to preserve the image similarities, as they are commonly perceived by humans when mapping from the original feature space to the new 2-dimensional space.

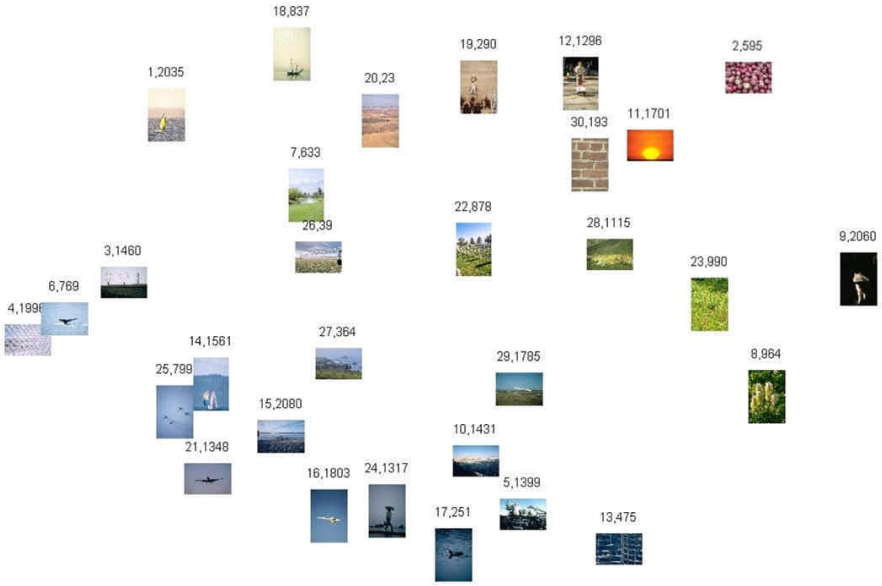

Figure 3: The first layer of the hierarchy giving the global view of the image database. (The numbers above each image represent the cluster ID at the first level and the clustroid ID in the image collection, respectively).

In measuring the effectiveness of a visualization system, we need to realize that the final evaluation will be done by a human. The human eye can only distinguish between a relatively small number of images at once; this number is miniscule in comparison to the thousands of images that are found in large image databases. Therefore, having a system that presents the user with all the images in the collection is obviously very limited. In our proposed system, the number of image points is reduced due to the use of cluster prototypes being displayed instead of the entire image collection. The data density will also be improved since the cluster prototypes represent clusters of similar images that were formed by maximizing the dissimilarities between the different groups of images. Since the user will be presented with much less

information, it should be much easier and simpler to explore the image database: having a general view of the database, the user obtains *details on demand* by just 'click on' actions performed on the eIDs.

3. CONCLUSION

As an overview, our proposed system allows users to explore the image database in order to browse, annotate, and formulate a textual or image query. As future work, we want to implement our system using other low-level features (texture and shape) in addition to those based on color information and experiment it on larger image databases.

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