Color Classification for Image Annotation

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Abstract

Capturing of the digital images using multimedia devices and the digital cameras is becoming increasingly more popular. Annotating the digital pictures is important to support the browsing, i.e. search pattern and retrieval of the images. Image annotation techniques depend entirely on visual properties of the image. The textual annotations or the tags with multimedia content are the most effective approaches to organize and to support search over digital images and multimedia databases. The image annotation preferred because as the countless images exist in our lives it is not possible to annotate them all by hand. And so annotation by computer is a potential and promising solution to this problem precisely. In this paper, color segmentation approach for image annotation is proposed. The region segmentation is performed by N-cut algorithm. RGB color space and HSI color space are mainly used for color classification and database creation. Several experiments have been done to confirm the effectiveness of the proposed method.

Keywords: Image Segmentation, Color classification, Image database, Annotation, Segmented parts

1. Introduction

The image annotation preferred because as the countless images exist in our lives, it is not possible to annotate them all by hand. And so annotation by computer is a potential and promising solution to this problem precisely. The ability to annotate images semantically based on the objects that they contain is essential in image retrieval as it provides the mechanism to take advantage of existing text retrieval systems.

Image semantic annotation was intended to add keywords automatically for images to represent the semantic content for the image; the visual features can be changed into the image annotation word information, involves not only the efficient search of keywords, but also overcomes the disadvantages of manual annotation in terms of time consumption.

Most studies in this field have focused on how to group images into semantically meaningful categories or index image in a database based on low-level visual features of the images. These systems follow the paradigm of representing image via a set of features such as color, texture, and shape[6]. Trong-Tˆon Pham[10] presents an automatic image annotation system using a fusion of region-based and saliency-based models .In this paper, he proposed three main stages of an automatic image annotation system. There are image processing, semantic learning, and annotation scheme. In image processing, they extract image data using region segmentation and saliency point detection.

Many segmentation algorithms have been created for different applications. The algorithms are used in traffic applications, army applications, web applications, medical applications, studying and many other applications. Image segmentation is fast and very important step in image analysis. Instead of looking at the value of total edge weight connecting the two partitions, our measure computes the cut cost as a fraction of the total edge connections to all the nodes in the graph. In this paper, Normalized cut (*Ncut*) algorithm for image segmentation is represented in equation1.

$$Ncut(A,B) = \frac{cut(A,B)}{assoc(A,B)} + \frac{cut(A,B)}{assoc(B,V)} \quad (1)$$

where $assoc(A,V) = \sum_{u \in A, t \in V} \omega(u,t)$ is the total connection from nodes in A to all nodes in the graph and *assoc(B, V)†* is similarly defined. With this definition of the disassociation between the groups, the cut that partitions out small isolated points will no longer have small Ncut value, since the cut value will almost certainly be a large percentage of the total connection from that small set to all other nodes.

The recent result of our research work related to segment the color for image annotation is presented. N-cut algorithm is developed for region segmentation. Five segmented parts are obtained by using N-cut algorithm traditionally. In proposed approach, six segmentation parts are extracted from the input image.

The aim of annotation methods is to attach textual labels to un-annotated images or the unlabelled images, as the descriptions of the content or objects in the images. The final goal of image annotation is mostly to perform image retrieval by providing users with a text based interface for search. The main idea of image segmentation is to simplify and change image into easier and meaningful form to analyze. Image segmentation is process, which locate objects in image. Moreover, the automatic segmentation algorithms in comparison with human segmentation results were tested.

To provide the creation of database, RGB and HSI color space are applied for color classification. Database of 5000 images of 100 different classes is used to check the performance of the algorithm developed.

The matched segmented part is searched by the principle component analysis (PCA) method for image annotation.PCA is a powerful and widely used linear technique in statistics, signal processing, image processing and elsewhere[11]. In general terms, PCA

uses a vector space transform to reduce the dimensionality of large data sets. Using mathematical projection, the original data set, which may have involved many variables, can often be interpreted in just a few variables (the principal components). It is therefore often the case that an examination of the reduced dimension data set will allow the user to spot trends, patterns and outliers in the data, far more easily than performing the principal component analysis. New test images were then matched to images in the database by projecting them onto the basis vectors and finding the nearest compressed image in the subspace (eigenspace).

The rest of this paper is organized as follows: section2 represents system overview, section3 consists the color image segmentation, section4 is the image database, section5 includes the experimental result and section6 is conclusion of the system.

2. System Overview

The system overview of the proposed automatic image annotation system is shown in figure1. According to the figure, the system starts user's desired image is input image to tag the label. The noise and errors in preprocessing of images (e.g., segmentation and edge detection) aggravates the matching problems. To solve this problem, edge detection, noise removal and center image subtraction is made as a enhancing step for image classification. After image enhancing process, image is clearly used for image segmentation. In image segmentation process, color classification is calculated by their color value. And then, these segmented parts compare with image database according to their color intensity using the principle component analysis (PCA).

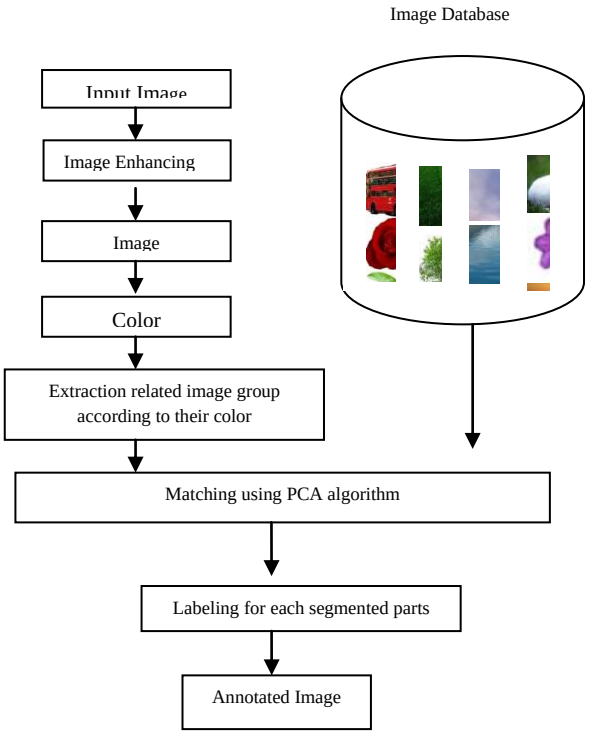

Figure1. System Flow Chart

Adding the segmented parts and labeling with their appropriate texts are processed to produce output image. The final output is annotated image with their relevant texts. An image retrieval system must produce images that a user wants. In response to a user's query, the system has to offer images that are similar in some user-defined sense. This goal is met by selecting visual features thought to be significant in human visual perception and using them to measure relevance to the query.

3. Color Image Segmentation

Image segmentation is a clustering technique used for image. In another word, it is a process of partitioning an image into multiple regions which have similar features, e.g., gray level, texture, color, etc. Image segmentation is a process of dividing an image into different regions such that each region is nearly homogeneous, whereas the union of any two regions is not. It serves as a key in image analysis and pattern recognition and is a fundamental step toward low-level vision, which is significant for object recognition and tracking, image retrieval, face detection, and other computer-vision-related applications. Color images carry much more information than gray-level ones. A graph cut is the process of partitioning a directed or undirected graph into disjoint sets. Graph cut methods have been successfully applied to stereo, image restoration, texture synthesis and image segmentation.

In the Normalized Cut framework [4] (Shi and Malik, 1997, 2000), which is inspired by spectral graph theory (Chung, 1997), Shi and Malik formulate visual grouping as a graph partitioning problem. The nodes of the graph are the entities that we want to partition; for example, in image segmentation, they are the pixels. The edges between two nodes correspond to the strength with which these two nodes belong to one group; again, in image segmentation, the edges of the graph correspond to how much two pixels agree in brightness, color, etc. Intuitively, the criterion for partitioning the graph will be to minimize the sum of weights of connections across the groups and maximize the sum of weights of connections within the groups. The eigenvectors can be thought of as a transformation of the image into a new feature vector space. In other words, each pixel in the original image is now represented by a vector with the components coming from the corresponding pixel across the different eigenvectors. Finding a partition of the image is done by finding the clusters in the eigenvector representation[2].

Color image segmentation is a process of extracting from the image domain one or more connected regions satisfying uniformity criterion which is based on features derived from spectral components. These components are defined in a chosen color space model[3]. In the RGB model, each color appears in its primary spectral components of red, green, and blue. This model is based on a Cartesian coordinate system. Color images follow a similar storage strategy to specify pixels' intensities. However, instead of using just one image plane, color

images are represented by three intensity components. These components generally correspond to red, green, and blue(the RGB model) although there are other color schemes.

An RGB image, sometimes referred to as a *truecolor* image, is stored as an *m*-by-*n*-by-3 data array that defines red, green, and blue color components for each individual pixel. RGB images do not use a palette. The color of each pixel is determined by the combination of the red, green, and blue intensities stored in each color plane at the pixel's location. Graphics file formats store RGB images as 24-bit images, where the red, green, and blue components are 8 bits each. This yields a potential of 16 million colors. The precision with which a real-life image can be replicated has led to the nickname "true color image." The component of RGB value is represented in Table1.

The process of color classification involves extraction of useful information concerning the spectral properties of object surfaces and discovering the best match from a set of known descriptions or class models to implement the recognition task [5].

Table1. RGB Color Component

Color	Red	Green	Blue
Black	0	0	0
White	1	1	1
Red	1	0	0
Green	0	1	0
Blue	0	0	1
Yellow	1	1	0
Magenta	1	0	1
Cyan	0	1	1
Gray	0.5	0.5	0.5
Dark red	0.5	0	0

Color segmentation is attractive because it is not computationally expensive. It can essentially be performed with a look up table. Color segmentation is easily adaptable to un-calibrated color cameras. Color is perceived by humans as a combination of tri-stimuli R(Red), G(green), and B(blue) which are usually called three primary colors. Several color spaces, such as RGB, HSI, CIE L*u*v* are utilized in color image segmentation, but none of them can dominate the others for all kinds of color images.

RGB is the most commonly used model for the television system and pictures acquired by digital cameras. Connected regions are easily extracted because they tend to be the same color. Since pixels are a mixture of three colors, this gives information that a luminance only image does not have.

4. Image Database

Digital Libraries of images and video are rapidly growing in size and availability. To avoid the expense and limitations of text, there is considerable interest in navigation by perceptual and other automatically extractable attributes. Unfortunately, the relevance of an attribute for a query is not always obvious. Queries which go beyond explicit color, shape, and positional cues must incorporate multiple features in complex ways. A grouping is a set of one or more image regions which are associated in some way. The elements of a grouping may not necessarily come from the same image [7].

Traditionally, access to multimedia libraries has been in the form or text annotation. Text provides a natural means of summarizing massive quantities of information. Text keywords consume little space and provide fast access into large amounts of data. In this paper, database is created according to their color intensity and their structure.

5. Experimental Result

Images in database are equally sized with 160*160 images. To compare images, image database with segmented parts are needed. So, the database is created by using segmented parts, general nature scene (e.g. sky, water, and grass), animals, vegetables and so on according to their color intensity. The objective of segmentation is to classify each RGB pixel in a given image as having a color in the specified range or not. After image segmentation process, the system classify image according to their color. And compare these images with images in database using PCA algorithm [1]. In database, all images are organized by their color (Red, Green, Blue and other).

Figure2. Some Input Images

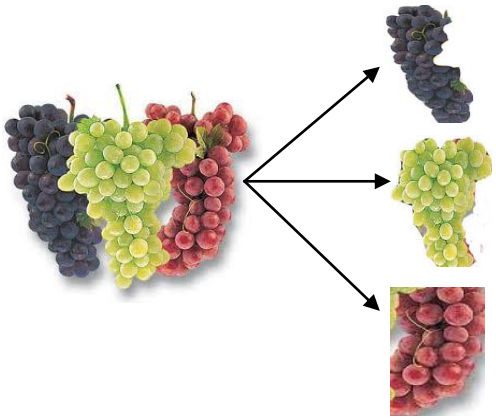

Figure3. Segmented parts of an input image

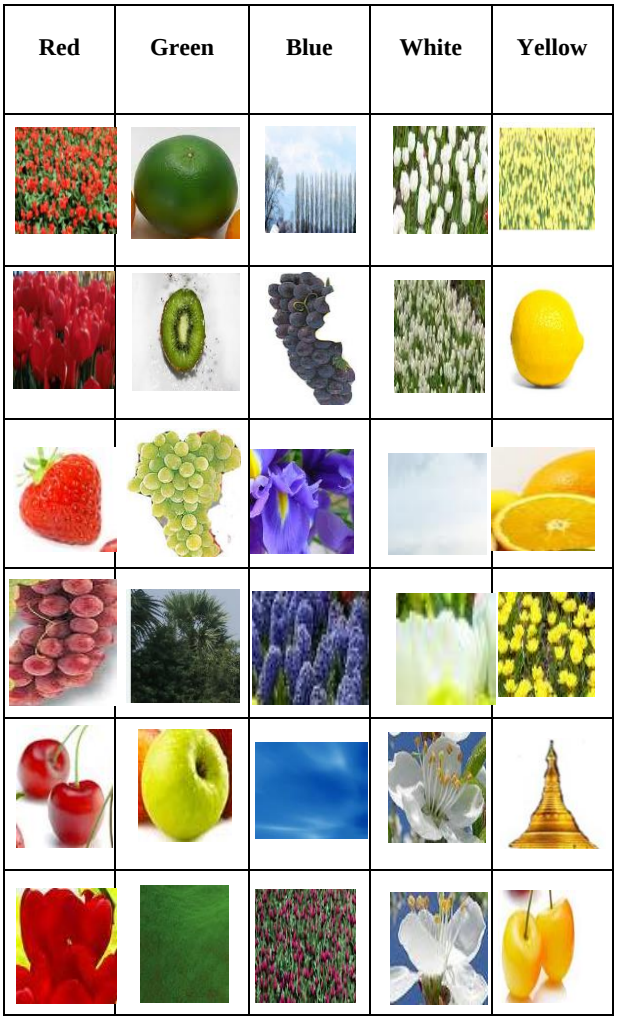

Figure4. The result of color classification

This is the reason for easy compare between input image and image in database. RGB color space and HSI color space is used for database creation. Some colorful input images are represented in figure2 , the segmented parts of an input image is shown in figure3, segmented parts of associated color component are classified in figure4 and their accuracy for color images(Red, Green ,Blue, White, Yellow) is represented in figure5.In this figure5, there is less accurate for white color because cloud and image's background are misunderstanding for this color. Sky and water are also have blue color intensity, so the system is not accurately classify.

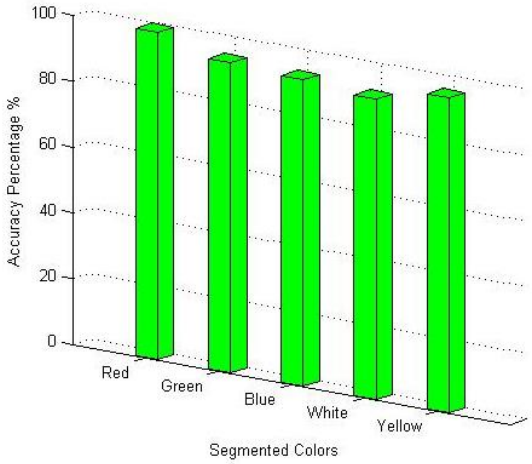

Figure5. Accuracy for images according to their color intensity

6. Conclusion

Manual image annotation is time-consuming, laborious and expensive; to address this, there has been a large amount of research done on automatic image annotation. In this paper, a method combining both color and texture features of image is proposed to improve the retrieval performance. Given a query, images in the database are firstly ranked using color features.. In this system, we use dataset where all annotations are approximately equal in length and words reflect prominence of objects in the image. Automatic image annotation emerged as a solution to the time-consuming work of annotating large datasets and as an intermediate step in the retrieval process. In this paper, color classification is the main process for image database to annotate image.

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