Getting a Glimpse of your Pictures using Dominant Colors

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Abstract
Nowadays, we have a lot of digital images in our collections often scattered in a disorganized way. This paper presents a new way to structure and visualize our database of pictures based on the two most dominant colors of each image. Our solution combines mechanisms from image retrieval with visualization techniques to give users an overview of their picture collection and also to allow them to search for similar images by using the dominant colors. To speed up the overall process, we use an inverted index where we replace the typical textual terms by the dominant colors.

Keywords
Dominant Color, Visualization, Treemaps, Inverted index, Image Retrieval

1. INTRODUCTION

Currently any normal user has a collection of thousands of digital photos. However, it is hard for them to quickly get an idea of the content of their libraries of pictures. In the majority of the cases users only get that summary by browsing the entire set of photos. Although there are applications to organize and visualize photos, like for instance Picasa or iPhoto, they do not provide any mechanism to give users an overview of the entire database.

To overcome this, we developed a tool that provides an effective overview of user's collections, by combining mechanisms from image retrieval, indexing and visualization techniques.

2. ACHIEVED SOLUTION

The solution developed to tackle this problem combines three different areas of research: multimedia information retrieval, to extract information from images; indexing structure, to provide an efficient mechanism to deal with large collections of pictures; and information visualization to effectively present the information to users.

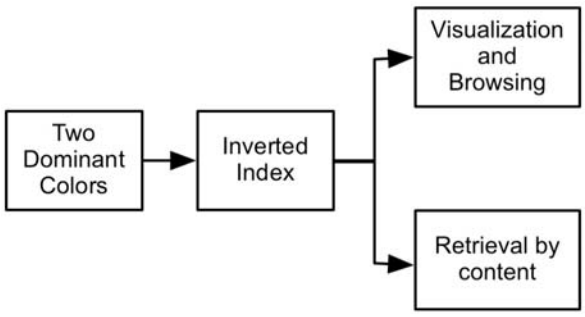

Figure 1 - Architecture of the solution.

Figure 1 illustrates how these three areas are mapped into the architecture of our solution. We start the process by resizing each image to 400x400px to uniform all the computational calculations and to improve the performance of the solution. Next we extract the two dominant colors from each image and then we use these to index the overall collection. Next, we use a visualization technique based on treemaps[Johnson91] to present the information about the number of pictures per dominant color. Finally, we developed a retrieval mechanism that uses the two dominant colors to find similar images.

2.1 Dominant Colors

Our first approach to identify the two dominant colors was to count the number of pixels for each color and select those with more pixels as dominants. We reduced the set of possible colors to 512 colors, to have a tradeoff between a relatively small number of colors and an expressive set. We plan to perform further studies to determine the number of colors that produces the best results.

The method of analyzing the color of all pixels within an image did not give us the expected results for the first and second dominant colors. For example, the resulting colors obtained from the image in Figure 2-a, were black and dark green. To the human eye, the obvious dominant colors are yellow instead of black, and a level of green.

a) b)

Figure 2 - Picture with expected yellow and green as dominant colors. Division of the image in 4x4 regions.

These results are explained by the different types of yellow that the flower has, promoting black and dark green as the colors with more pixels, followed by the various types of yellows. To correct this, we tried to reduce the number of colors forcing all the different kinds of yellow to just one, but it did not produce the desired results.

In the solution achieved, we divided the image in 4x4 regions and applied the algorithm to each part [Natsev04] identifying the two dominant colors on each (see Figure 2-b). After, we combine the values from the various regions and we identify the first and the second dominant color of the overall image. With this method we achieved results more similar to what users were expecting as being the main colors of a certain image, as we checked informally with some users.

2.2 Index Creation

To provide an efficient solution able to deal with large collections of images, we included an indexing mechanism, based on the inverted index. This consists of an indexing structure that stores mappings from content, usually words or numbers, to its locations in a database file, or in a set of documents. Although it is mainly used to index text, we decided to adapt it to the domain of images, by replacing words by colors. So, instead of having words as terms we have the dominant colors (the first and the second) as keys in the index, and images as documents. Below is an excerpt from our inverted index:

```
yellow: {sun.jpg}
orange: {sun.jpg, fruit.jpg}
green:  {leaf.jpg, tree.jpg}
red:    {pt_flag.jpg}
blue:   {beach.jpg, tree.jpg}
```

2.3 Visualization

To visualize the photo collection we implemented a view based on treemaps [Johnson91]. Treemaps are a good visualization technique to provide an overview of a large database collection by visualizing different sized rectangles. Usually, they are used to represent hierarchical tree structures, but in our case we only have one level that represents all the dominant colors.

When the color and size dimensions of these rectangles are correlated in some way with the tree structure, one can often easily see patterns that would be difficult to spot in other ways. A second advantage of treemaps is that they make an efficient use of space. As a consequence, they can legibly display thousands of items on the screen simultaneously.

In our application, each square represents a different dominant color. Its size is directly related to the number of pictures with that color and the square color is the dominant color (see Figure 3). As we can see from Figure 3, users can easily get an overview of their collection. For instance, we can see that in this collection we have more pictures with blue and red (top left) than with green (bottom right area).

To see images with a specific dominant color users just have to click on the desired color, and pictures will appear on the right side of the application screen (see Figure 3 right). It is also possible to retrieve images by specifying two dominant colors. In this case the application searches the inverted index to find images that have the two colors in common.

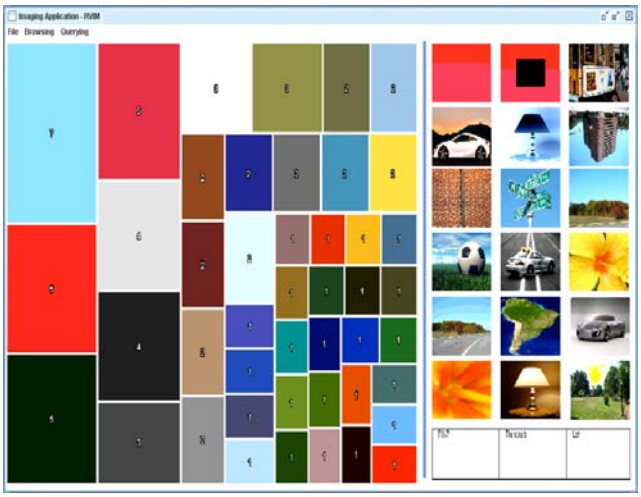

Figure 3 - Screenshot of the application to visualize image collections. Each square represents a dominant color and its size is proportional to the number of pictures with that color.

3. CONCLUSIONS AND FUTURE WORK

We describe our approach for presenting a quick overview of collections of images. To that end we exploit the concept of dominant color to convey information about pictures. Dominant colors are also used as “words” to create an inverted index, for assuring good performance. We believe, and some preliminary tests showed it, that our solution is able to deal with large collections of photos (1,000+). We then used a visualization technique based on treemaps to display the information about the distribution of images per color. With this, users can quickly take a glimpse at their picture collections.

Although this tool allows users to quickly browse and search for images in their collections, we plan to integrate this mechanism, based on the dominant colors and on the inverted index, into a more generic content-based image retrieval solution. Our idea is to use this as a first filter while performing the search for similar images. That way, in a second step we can use algorithms that require more computational effort, since the number of pictures to compare is smaller.

4. REFERENCES

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