Chapter 7
A Survey on Feature Based Image Retrieval Techniques

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ABSTRACT

In this chapter, we review classical and state of the art Content-Based Image Retrieval algorithms. Techniques on representing and extracting visual features, such as color, shape, and texture, are first presented. Several well-known image retrieval systems using those features are also summarized. Then, two recent trends on image retrieval, namely semantic based methods and local invariant regions based methods, are discussed. We analyze the drawbacks of current approaches and propose directions for future work.

INTRODUCTION

With the rapid growth of the Internet, a huge number of images are produced and stored every day. The need to retrieve relevant images from a huge and growing database is shared by many groups, including radiologists, journalists, librarians, photographers, historians, and database engineers. Most existing Image Retrieval systems are text-based. Traditionally, Images are first annotated using text, and then text-based Database Management Systems are used to perform Image Retrieval. However, the content in an image is often not well captured using words, which results in erroneous or inaccurate annotation. Furthermore, manually annotating millions of images is a time-consuming and tedious task. Another drawback of text-based image retrieval results from the subjectivity of human perception, i.e. for the same image content, different people may perceive it differently.

Disadvantages with text-based image retrieval have provoked growing interest in the development of Content-Based Image Retrieval (CBIR).

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That is, instead of being manually annotated by text-based keywords, images are indexed by their visual content, such as color, texture, etc. The performance of a CBIR system is highly dependent on the distinctiveness and robustness of the visual features extracted from an image.

The remainder of this chapter is organized as follows. In Section 2, visual feature representation and extraction is discussed. Feature extraction is the basis of Content-Based Image Retrieval. Features discussed include color, texture, shape and spatial layout. An overview of a number of commercial and research CBIR systems is presented in Section 3. In Section 4, recent work in CBIR is reviewed. Finally, the conclusion is drawn in Section 5.

VISUAL FEATURE REPRESENTATION AND EXTRACTION

The representation of visual features in images is a fundamental issue in Content-Based Image Retrieval. Computer vision and pattern recognition algorithms provide the means to extract numerical descriptors which give a quantitative measure to such features. The features employed in most CBIR techniques include: color, texture, local shape and spatial layout. The following is a brief description of some current methods for extracting such features and the similarity measures between such features.

Color Representation

Color is one of the most widely used visual features in Image Retrieval. It is relatively easy to compute and is independent of image size and orientation. The perception of color is dependent on the chromatic attributes of images. From a physical point of view, color perception is dependent on the spectral energy distribution of the electromagnetic radiation that strikes the retina. From the psychological point of view, color perception is related to several factors, including color attributes (brightness, chromaticity and saturation), surrounding colors, color spatial organization, the viewing surround, the observer's memory/knowledge/experience, etc (Bimbo, 1999).

Several ways have been proposed for representing color. The RGB color representation is a reasonable choice when there is little variation in the recording or in the perception, since the representation is designed to match the cone color channels of the eye. An image expressed as (R, G, B) makes most sense for processing digitized paintings, photographs and trademarks, where the planar images are taken in frontal view under standard conditions. The use of opponent color representations (Swain and Ballard, 1991) makes a substantial improvement to the RGB color representation. The employment of opponent color axes (R-G, 2B-R-G, R+G+B) has the advantage of isolating the brightness information on the third axis. The first two (chromatic) axes can be down-sampled, since humans are more sensitive to brightness than to chroma. The CMY (Cyan, Magenta, Yellow) color representation is usually used for color printing (Sharma, 2003). They are the complements of Red, Green and Blue, and are called subtractive primaries since they are obtained by subtracting light from white. The HSV (Hue, Saturation, Value) representation is often used because of its invariant properties (Gonzalez and Woods, 2002). For example, the hue is invariant under camera rotation and illumination changes, so is more suitable for image retrieval.

Color histograms are one of the most commonly used color feature representations in Image Retrieval. They are obtained by discretizing image colors and identifying the proportion of pixels within an image having specific values. The color histogram of a circular image region is invariant to camera rotation, because rotation does not change the proportion of pixels that have particular color intensity levels inside the circular region. Zoom also does not affect the color histogram of an