CONTENT BASED IMAGE RETRIEVAL: A REVIEW OF FEATURE REPRESENTATION TECHNIQUES

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Introduction

Recent advances in computer technology facilitate for storage and retrieval of large amount of text, images, audio and video data. Image data is employed in different areas such as art, entertainment, advertising, history, medicine and industry. Image retrieval is the most common activity in all areas. Content-based image retrieval (CBIR) is proven to be success in retrieving digital images (Fuhui, *et al.*, 2003).

Feature extraction and representation is the fundamental process in any CBIR system. According to the visual feature scope features can further be classified as general features and domain specific features. General features include color, texture, shape and spatial layout. This paper reviews the techniques used for representation of general features.

Color Representation

Color is one of the most commonly used visual features in image retrieval. It is independent of size, orientation of the image and is very effective in representing background complications.

Color histogram is used for the efficient representation of the color content of an image if the color pattern is unique compared with the rest of the data set. However, histogram comparison will saturate the discrimination when database size is very large. To solve this problem, the joint histogram technique is also introduced (Fuhui, *et. al.*, 2003).

Color moments proposed by Stricker and Orengo (John and Sitharam, 2001) is very compact representation compared to other color features. Usually three moments: first order (mean), second order (variance) and third order (skewness) moments are defined. These moments are defined according to the i^{th} color component of the image pixel j and the number of pixels (N) in the image.

Color coherence vector (CCV) (Long, 2003) is another representation used when images have either mostly uniform color or mostly texture regions. A color coherence vector represents this classification for each color in the image. CCVs prevent coherent pixels in one image from matching incoherent pixels in another. This allows fine distinctions that cannot be made with color histograms.

Color correlogram characterizes the color distributions of pixels and spatial correlation of pairs of colors (John and Shih-Fu, 1996). Salient feature of this approach is that it takes into account the local color spatial correlation as

well as the global distribution of the spatial correlation.

Texture Representation

Texture refers to the visual patterns that have properties of homogeneity that do not result from the presence of only a single color of intensity (John, *et al.*, 1996). The texture representation methods are classified into two groups: structural and statistical. The structural methods describe the texture by identifying structural primitives and their placement rules. Statistical methods are effective in CBIR. Wavelet transformations including orthogonal and bi-orthogonal wavelet transformations, tree structured wavelet transformation and Gabor wavelet transformation were also used for texture representation and analysis.

Shape Representation

There are two categories of shape representations: boundary based and region based representations. Boundary based representation is based on the outer boundary of the shape only. Region based representation is based on the entire region of the shape. Fourier descriptor found to be the most successful candidate for boundary based representation. This method uses the Fourier transformed outer boundary of the shape as the feature. For region based shape representation Moment invariant found to be the best candidate. This method uses region based moments as shape features. These moments are invariant to geometric transformations.

Spatial Layout

Spatial information is very much useful when the regions or objects with similar color and texture properties can be easily distinguished by imposing spatial constraints. The 2D strings are the most widely used representation for spatial relationship. 2D-G strings, 2D-C strings and 2D-B strings are variants of this representation.

Conclusions

Different feature extraction methods perform differently according to certain assumptions and conditions. The content-based image retrieval techniques based on low level features capture only one aspect of an image property. According to the different techniques used to represent the same feature may have different success rates depending on the application requirements and image database. Even though existing features facilitate the retrieval of image for various applications it is very difficult to claim that one feature is superior to the other.

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