Chapter 82

A Fast New Rotation Insensitive WP–Based Method for Image Indexing and Retrieval

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ABSTRACT

Large multimedia databases and digital image archival systems are being created in government, academia, military, hospitals, digital libraries, and businesses. Efficient methods to retrieve images from such large databases have become indispensable. In this chapter, the authors present a novel Wavelet Packet (WP)-based method for image identification and retrieval that enables the recovery of the original image from a database even if the image has been subjected to geometric transformations such as size-conserving rotation or flipping operations. The proposed method uses the correlation of wavelet packet coefficients to create an image signature. This signature is comprised of two parts. The first part is a short signature, SS, that represents the location of specific values of the WP coefficient correlations in each frequency band. The second portion is the basis signature of the image, which is a long signature, LS, of 1296 correlation points produced by summing up the correlation values along all frequency bands. Computer simulation results show that the method is extremely fast, has a perfect image retrieval rates (100%), and perfect geometric transformations recognition, if any. In addition, the simulation results show that target images are perfectly identified from an image database of 7500 image signatures within a short period of time (nearly 8 seconds on the average). This method is robust against geometric transformation and requires minimal data transfer and can be used for online image retrieval.

INTRODUCTION

The rapid growth of the Internet and the significant expansion of digital multimedia bases in the past years have sharply increased the availability of digital data such as audio, text, images and videos to the public. This huge amount of information offered online and inter-networks require efficient retrieval systems to allow fast access to that incredible amount of content at minimal computational cost. Such
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requirement represents an interesting challenge especially for image retrieval, which is the focus of this research. This is why so much attention has been drawn towards the development of content-based image retrieval (CBIR) systems as well as other algorithms in the last decade.

This chapter is organized as follows: At first, we present a survey of the previous work done in the area of image retrieval and then we discuss why we chose wavelet packets, WP, over standard wavelets. After the survey, we introduce our image retrieval method. In this section, we explain the way we created the image database and present the simulation results. Finally, we provide the conclusions.

Previous Work

A great deal of work has been done to develop texture, color, shape or content-based indexing procedures for image signature production for image retrieval process (Seng Chua, Tan & Chin Ooi, 1997; AlZahir, 2006; Quellec, Lamard, Cazugue & Cochene, 2010; Schroder & Laurent, 1999; Nicchiotti & Ottaviani, 1999; Kliot & Rivlin, 1998; Wenyin, Wang & Zhang, 2000; Vailaya, Figueiredo, Jain & Zhang, 2001). Because of the many advantages of wavelet representation, some systems use characteristics extracted from wavelet analysis. Venkatachalam (2000) discussed a single stage technique, which addresses the image segmentation / classification problem. This technique is performed at the pixel level using an energy density function based on the wavelet transform, WT. Instantaneous energy distribution, called Pseudo Power Signature, is used as the image signature. Its effectiveness and low computational and storage requirements are also discussed.

Romberg, Choi, Baraniuk and Kingsbury (2000) extended on the hidden Markov tree-modeling framework of the complex wavelet transforms to take advantage of its near shift-invariance property and improve angular resolution. By focusing on salient signal features, the model can be used to solve the supervised classification problem more efficiently than methods based on traditional WT. However, the required training of the HMT models for each required sample certainly set limits on the technique’s practical application.

Scott and Nowak (2000) introduced a hierarchical wavelet-based framework for modeling patterns in digital images. They used the marginal pdf of the significant and insignificant wavelet transform coefficients (WTC) to specify the joint distribution of the WTC of a linearly transformed pattern template. With results obtained from real images, the Template Learning from Atomic Representation technique is proven to be efficient in extracting a low dimensional template, representing the defining structure of the pattern while rejecting the noise or the background.

Loupias, Sebe, Bres and Jolion (2000) presented a salient point detector based on Wavelet Transform that extracts points where variations occur in the image. Large WTC at coarse resolution are found and then their largest children coefficients are tracked up to the finest scale. The authors present a retrieval experiment with Gabor features and demonstrate that their method performs better than other point detectors.

A method for representing texture information in images using dual tree complex Wavelet Transform (DT-CWT) is presented by Hatipoglu, Mitra, and Kingsbury (2000). The image texture is represented using magnitude quantization of DT-CWT coefficients, to extract the significance of each subband, and separate coding of phase information. In the retrieval process, the similarity of images is defined according to the Euclidean distance between the significant values of their subbands. Using images from real image databases, the authors verified the efficiency of their method in extracting texture features from encoded data.