Chapter 8
A Perceptual Approach for Image Representation and Retrieval: The Case of Textures

Noureddine Abbadeni
King Saud University, Saudi Arabia

ABSTRACT
This chapter describes an approach based on human perception to content-based image representation and retrieval. We consider textured images and propose to model the textural content of images by a set of features having a perceptual meaning and their application to content-based image retrieval. We present a new method to estimate a set of perceptual textural features, namely coarseness, directionality, contrast and busyyness. The proposed computational measures are based on two representations: the original images representation and the autocovariance function (associated with images) representation. The correspondence of the proposed computational measures to human judgments is shown using a psychometric method based on the Spearman rank-correlation coefficient. The set of computational measures is applied to content-based image retrieval on a large image data set, the well-known Brodatz database. Experimental results show a strong correlation between the proposed computational textural measures and human perceptual judgments. The benchmarking of retrieval performance, done using the recall measure, shows interesting results. Furthermore, results merging/fusion returned by each of the two representations is shown to allow significant improvement in retrieval effectiveness.

1. INTRODUCTION
Texture has been extensively studied and used in literature as it plays a very important role in human visual perception. Defining texture is not that easy; however some intuitive concepts can be defined about texture. Texture refers to the spatial distribution of grey-levels and can be defined as the repetition of one or several primitives in an image, in a deterministic or random way. Microtextures refer to textures with small primitives while macrotextures refer to textures with large primitives (Tomita & Tsuji, 1990; Tuceryan & Jain, 1993; Van Gool, Dewaele, &
Texture analysis techniques have been used in several domains such as classification, segmentation, shape from texture, and image retrieval. In a general way, texture analysis techniques can be divided into two main categories: spatial techniques and frequency-based techniques. Generally, the frequency-based methods are based on the analysis of the spectral density function in the frequency-based domain. Such methods include the Fourier transform and the wavelet-based methods such as the Gabor model. Spatial texture analysis methods fall in one of the following classes: statistical methods and structural methods (Haralick, Shanmugam, & Dinstein, 1973; Haralick 1979; Jain, Kasturi, & Schunck, 1995; Solberg & Jain 1997; Tuceryan & Jain, 1993).

The majority of the existing methods applied on textures have many drawbacks. In fact, statistical methods seem to give results better in the case of microtextures while structural methods give better results in the case of macrotextures. These methods, whether they are statistical, structural or hybrid, have another drawback not less significant: the computational cost. In fact, most of these methods necessitate a very significant computation cost. At the opposite, the human visual perception seems to work perfectly for almost all types of textures (Amadasun & King, 1989). The differences between textures are usually easily visible for the human eye while the automatic processing of these textures is very complex. One reason for this mismatch between human vision and computational models proposed in literature is the fact that the majority of computational methods use mathematical features that have no perceptual meaning easily comprehensible by users. In this paper, we are interested in textural features that have a perceptual meaning for users. It is widely admitted that there is a set of textural features that human beings use to recognize and categorize textures. Among these features, we can mention coarseness, contrast and directionality (Amadasun & King, 1989; Tamura, Mori, & Yamawaki, 1978). In such a perceptual approach, and in order to simulate the human visual perception system, we must dispose of computational techniques that allow a quantitative and computational estimation of the mentioned perceptual textural features. This is exactly the problem we are tackling in this paper: given a set of perceptual textural features, namely coarseness, contrast, directionality and busyness, that humans use to distinguish between textures, how can one simulate them with quantitative and computational measures that correspond, to an acceptable degree, to human perception? Then, how such perceptual features perform when applied in texture retrieval?

There are some works published in literature on the subject of human visual perception since the early studies done by Julesz (1976) and Bergen et al. (1988). However, there are two main works that are closely related to our. The first work is done by Tamura et al. (1978) and the second work is done by Amadasun et al. (1989). Each of the two has for a set of textural features. The work of Tamura et al. (1978) was based on the co-occurrence matrix and the work of Amadasun et al. (1989) was based on a variant of the co-occurrence matrix called NGTDM (neighborhood grey-tone difference matrix). The results obtained by both of them were good compared to the human perception. Another work done by Ravishankar et al. (1996) in which the authors present what they call a texture naming system: they have made an attempt to determine the relevant dimensions of the texture, as in the case of color (RGB, HSI, etc).

The objective we are following in this work falls into this global framework. We propose, however, a new method to estimate a set of perceptual textural features. The perceptual model proposed is evaluated using a psychometric method (based on rank-correlation) and found to correspond better to human judgments compared to related works (Tamura et al. (1978); Amadasun et al. (1989)). We apply the proposed perceptual model to texture retrieval and show interesting results. Furthermore, to improve retrieval efficiency, we
Related Content

Analysis of the Performance of Eigenfaces Technique in Recognizing Non-Caucasian Faces
www.igi-global.com/article/analysis-performance-eigenfaces-technique-recognizing/75769?camid=4v1a

Optimal Image Segmentation Methods Based on Energy Minimization
www.igi-global.com/chapter/optimal-image-segmentation-methods-based/4835?camid=4v1a

From Data to Knowledge: Data Mining
www.igi-global.com/chapter/data-knowledge-data-mining/48393?camid=4v1a

On the Analysis of Global and Local Robust Image Watermarking Using Zernike Moments
www.igi-global.com/article/on-the-analysis-of-global-and-local-robust-image-watermarking-using-zernike-moments/111476?camid=4v1a