Vision Interface '99, Trois-Rivières, Canada, 19-21 May

MRMRF Texture Classification and MCMC Parameter Estimation

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Abstract

Texture classification is an important area in the field of texture analysis. In this paper, we propose a novel stochastic approach–multiresolution Markov Random Field (MRMRF) model to represent textures and a parameter estimation method based on Markov chain Monte Carlo method is proposed. The parameters estimated from the decomposed subbands can be used as features to classify textures. The classifier used here is nearest linear combination(NLC) which uses the combination of the features of several prototypes of an original texture to fit the features of the query texture. This method is better than NN(nearest neighbor) classifier. The experiment results illustrate the effectiveness of our method.

1. Introduction

Texture is one of the basic characteristics of a visible surface and it provides important information for scene interpretation as well as image processing. It plays a crucial role in computer vision and pattern recognition. Understanding texture is a great part in image understanding. Texture analysis has broad applications in image database retrieval, industrial and biomedical surface inspection, ground classification and digital library. During the past decades, a lot of methods have been proposed with different objectives to interpret textures. All these methods can be classified into three categories: statistical, spectral and structural. Since the natural textures are not very regular in nature, the structural techniques are not very popular now. Statistical techniques characterize texture by the statistical properties of the graylevels of the points comprising a surface. Co-occurrence statistics[1], Markov random field modeling[2], autoregressive moving average model[3], and Gaussian MRF models[4] can be classified into statistical techniques. Spectral techniques are based on the properties in the spatial-frequency domain in which the directionality and periodicity are much easier to be identified. Spectra Fourier power spectrum[5], digital transformation[6], and Wold decomposition[7] are spectral techniques. In recent years, filtering theory becomes a popular trend to analyze textures. Filtering theory is based on multichannel filtering mechanism. Gabor filters[8] and wavelet filters[9] are two approaches of filtering theory. Although filtering theory has excellent performance in image denoising, classification and segmentation, some problems are not well understood according to the paper of Zhu and Mumford[10]. For example, how to select a best set of filters from a filter bank and how to fuse the features captured by them into a single texture model.

Zhu and Mumford[10][11] proposed FRAME model and GRAGE model to combine filtering theory and stochastic models through maximum entropy principle. In their theory, the two homogeneous textures are often difficult to discriminate when they produce similar marginal distributions for responses from a bank of filters. That means the marginal distributions can be used to represent the original image. However, in their method, the parameters in the model have to be estimated by comparing the marginal distributions between the expected texture and the real texture iteratively, thus the expected texture has to be sampled many times until the expected texture has the similar marginal distributions with the original texture. This is a time consuming procedure. From the viewpoint of MRF modeling, FRAME model only considered the one-site cliques in the filtered images. In this paper, we will discuss how to combine MRF and filtering theory again and more information in the filtered images can be revealed. Thus textures can be represented more accurately. During the past years, two categories of MRF