Maximum Entropy Random Field Model for Texture Analysis

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Abstract

It is well known that stochastic models, such as MRF and AR model, suffer from their poor capability to describe complicated textures. By introducing filters into these random field models appears to be a new approach to overcome the problem. In this paper, we present a new model for texture analysis, which integrates filter theory into random field based on Maximum Entropy theory. And parameter estimation employing Markov Chain Monte Carlo (MCMC) is proposed for this new model.

Key words: Maximum entropy, texture modeling

1 Introduction

AR model and MRF model have been applied to the field of texture research many years ago[1], [2], [3], [4]. The randomness in texture is the main reason why people consider random field as one of possible ways to model and analyze texture images. But these random field models seem not adequate to represent the texture image effectively.

Intuitively, texture seems to stand between noise and signal. If we choose random field as texture model, then our model is likely close to noise and far from signal. Actually, when facing the task of shaping random field into texture models, people have difficulty in imposing proper constrains on random fields to bring the structure information into texture models.

The FRAME model, proposed by Zhu [5], introduces filters into random field models to extract texture features. This idea combines filtering theory and Markov random field modeling through the maximum entropy principle. With FRAME model, Zhu has tried to interpret and clarify many previous concepts and methods for texture analysis and synthesis from a unified point of view[6].

In this paper, we propose a different model of integrating filter theory with random field. The new model is called maximum entropy random field model. In this texture model, we use filter to directly describe the contextual constraints in texture. Maximum entropy method was employed to construct the joint probability distribution for texture image. For the purpose of fitting this maximum entropy random field model to natural texture, we propose a parameter estimation method based on MCMC.

This paper is organized as follows. Our new texture model will be explained in section 2, its MCMC parameter estimation method in section 3 and experiment results in section 4. Section 5 is conclusion and future work.

2 Maximum Entropy Random Field Model

The objective of random field texture modeling is to find the contextual constraints in texture and describe it. Maximum entropy random field model proposed in this paper assumes the contextual constraint, and employs maximum entropy method to construct the joint probability distribution for texture image.

The reason for the choose of maximum entropy method (MEM) is that MEM suggests one joint probability which has the greatest entropy after meeting