CCIT REPORT #838 August 2013

Superresolution of self-similar textures

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August 22, 2013

Abstract

Texture enhancement presents an ongoing challenge, in spite of the considerable progress made in recent years. Whereas most of the effort has been devoted so far to enhancement of regular textures, stochastic textures, which exhibit fine details, are encountered in most natural images wherein they still present an outstanding problem insofar as superresolution enhancement is concerned. In this work, a texture model, based on fractional Brownian motion (fBm), is proposed. The model is based on our observation that, contrary to previous findings that images are not characterized by Gaussian distributions, natural stochastic textures (NST) are Gaussian. The model is global and does not entail using image patches. The fBm is a self-similar stochastic process. The self-similarity is known to characterize a large class of natural textures. The fBm-based model is evaluated and a single-image regularized superresolution algorithm is derived. The algorithm is useful for a wide range of textures. Its performance is compared with state-of-the-art single-image superresolution methods and its advantages are highlighted.

1 Introduction

Single-image superresolution (SR) has attracted considerable attention in recent years and still considered to be one of the most outstanding problems in advanced image processing [1–6]. This is a challenging task, since the original (source) image has to be recovered using only the degraded, subsampled, image. While traditional approaches to image enhancement in terms of denoising, deblurring and contour emphasis result in sharper images, they often yield an unnatural cartoon-like image, compromising on the quality of, and almost even eliminating, some textures. This compromise in image fidelity highlights the observation that textures are an important ingredient of image structure, that must be considered in the context of image enhancement tasks.

Common methods for image enhancement may not work on stochastic textures, and in many cases, other approaches are required for texture enhancements. Image enhancement algorithms, used in deblurring and denoising methods, generally