CCIT Report #833 June 2013

A Total Variation Spectral Framework for Scale and Texture Analysis

Guy Gilboa

Department of Electrical Engineering,
Technion - Israel Institute of Technology,
Haifa 32000, Israel

June 30, 2013

Abstract

A new total variation (TV) spectral framework is presented. A TV transform is proposed which can be interpreted as a spectral domain, where elementary TV features, like disks, approach impulses. A reconstruction formula from the spectral to the spatial domain is given, allowing the design of new filters. The framework allows deeper understanding of scales in an L^1 sense and the ability to better analyze and process textures. An example of a texture processing application illustrates possible benefits of this new framework.

1 Introduction

The total variation (TV) functional is today a fundamental regularizing tool in image processing. It is employed for denoising and deconvolution [41, 15, 36, 38, 37, 27], optical-flow [10], tomographic reconstruction [42], texture and image analysis [8, 5, 3, 46, 28] and more. Since its introduction in [41] in the context of image processing many studies have been devoted to its analysis and interpretation, e.g. [15, 36, 16, 17]. We attempt in this paper to further enhance the intuition and applicability of this functional to feature extraction and image analysis by formulating a spectral framework, where one can decompose and reconstruct images using the basic TV elements of the image.

Spectral analysis has been used extensively in the analysis and processing of signals modelled as stationary random processes (see e.g. [33, 44]). For more complex non-stationary signals, such as images and speech, harmonic analysis methods were developed in the form of wavelets [21, 35, 23], spectral graph theory [18] and diffusion maps [19]. We explore a way to provide spectral information for total variation analysis.