Chapter 6
Noise Removal With Filtering Techniques

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ABSTRACT

An overview of the image noise models and the de-noising techniques available are presented here. Basically, filtering is one of the de-noising approaches that is normally performed in both spatial and frequency domains. Thus, this chapter focuses on these two approaches. Few filters like mean, median, sharpening, and adaptive median filter are discussed under spatial domain. In the frequency domain, as Butterworth filter suits better for images, Butterworth low pass, high pass, and band pass filters along with homomorphic filters are also analyzed. It also provides a comparative analysis of these approaches for both synthetic and medical images with some performance measures.

INTRODUCTION

Noise is unwanted information and it is an unavoidable one in handling images. It may appear in images either during image capturing or during image processing. A fundamental fact in noise analysis is that, it is very hard to analyze and remove noises from the digital images without the previous understanding of the noise model. Hence, review and statistics of noise models are essential before going to know about noise removal techniques. The noise may disturb audio, video and still images. As the noise is a random one, it will affect the actual information based on the level of noise added. Image distortion is one of the most predominant problems in image processing. Image distortion is studied with the fundamental noise types in

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digital images such as Gaussian, Poisson, Speckle, Salt and Pepper, Structured noise and Shot noise etc., (Gonzalez R. C., & Woods R. E., 2002). The source of these noises is the sensors in the camera used for image acquisition, miss-calibration of the camera lenses, the movement of the objects while capturing the images and the illumination condition. It may be even due to the miss-adjustment of focal length of lenses and Image Processing (Kailas, T.). So, a detail study about the noise model is an essential one for image de-noising.

RELATED WORK

Image de-noising plays a vital role in image analysis. Any image de-noising technique should remove noise as much as possible and make the image in convenient form for further analysis. Image de-noising approaches were proposed both for spatial and frequency domain in earlier days. Generally, the initial papers suggested in spatial domain removes edges also while removing noise pixels. Hence weighted median (Yang et al., 1995), relaxed median (Ben Hamza et al., 1999) and adaptive median based techniques were proposed to overcome this drawback. Mean filter is a kind of linear filter, which also fails to collect all line and edge details. Wiener filter (Jain.A.K, 1989) is also a linear filter but, it works well only for the smooth images. In the frequency domain, Fast Fourier Transform is used as one of the method. Wavelet transform can also be used to convert into other domain (Strela et al., 2000). Wiener filter after taking wavelet transform provides optimal results (Choi et al., 1998). A wavelet-domain spatially adaptive FIR Wiener filtering (Zhang et al., 2000) for image de-noising is also proposed in the literature. Non-linear filter with hard and soft thresholds are also available (Donoho, 1995). But, it may not produce faithful results always as it has spurious artifacts. Thus combined wavelet and thresholding techniques are also proposed. Lang et al., presented a normal hard/soft threshold with Shift Invariant Discrete Wavelet Transform in the year 1995. Shift Invariant Wavelet Packet Decomposition (SIWPD) is exploited to obtain number of basis functions (Cohen et al., 1999). Other de-noising method based on wavelet coefficient trees is proposed by Donoho in the year 1997. The Independent Component Analysis method was successfully implemented for de-noising non-Gaussian data (Jung, 2001). ICA method is applicable both for Gaussian and non-Gaussian data (Hyvärinen et al., 1998).