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Adaptive Selection of Search Region for NLM Based Image Denoising

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Abstract

The Non-Local Means (NLM) algorithm exploits the self-similarities or repeated patterns present in the whole image or a predefined search window for denoising the image. The size of the search window plays a crucial role in the performance of the NLM algorithm. If the search window used in the algorithm is larger than the required size, then it leads to over smoothing of the image whereas the choice of a smaller search window may result in inadequate noise removal. Therefore, ideally, the search window size must optimally vary from region to region based on the characteristics of the search region. The proposed algorithm selects an optimal size of search window for each pixel such that the variance of search region in the filtered image is close to the estimated variance of the corresponding region in an original image. The experimental results have shown that the proposed algorithm performs better than the original NLM and other state-of-the-art algorithms in terms of PSNR(dB), SSIM and visual quality for denoising the standard test images.

Keywords: Image denoising, Non Local Means (NLM), search window size, variance estimation, and search region characteristics.

1. Introduction

Denoising is still one of the most fundamental and important task in image processing applications such as image restoration, visual tracking, segmentation, and registration etc. Due to rapid growth of multimedia technologies, imaging devices manufacturers always require new denoising algorithms for improving the quality of an image. The main purpose of image denoising is to estimate original image from the noisy image, while preserving the important image details such as edges/textures effectively [1]. In recent years, a wide range of image denoising techniques have been proposed to handle the denoising problem [2]. Image denoising methods are classified into two categories: spatial and transform domain. The spatial and transform domain methods can also be further categorized as local and non-local. The local methods exploit the spatial redundancy in local neighborhoods only. Most of the transform based image denoising methods are local methods [3, 4]. The non-local methods estimate the pixel value by exploiting the similar patterns and features present in the whole image or a predefined search region in an image. Traditional spatial denoising method like Bilateral filtering [5] restores the pixel value based on the radiometric and photometric similarity in a predefined search window. Perona-Malik model [6] recovers an image using the gradient information of each pixel. It introduces some artifacts and staircase

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