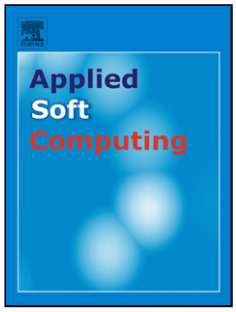

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Learning based restoration of Gaussian blurred images using Weighted Geometric moments and Cascaded digital filters

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Abstract

Image moments such as Zernike, Tchebichef and Geometric moments have been widely used in image processing applications. They have useful properties to detect edges. In this paper, we present how one of the moment families, in particular Geometric moments (GM) can be utilized in estimating the sigma and size of the Gaussian point spread function (PSF) that degrades the images. With the knowledge of how edges vary in the presence of Gaussian blur, a method that uses low order geometric moments is proposed to estimate the PSF parameter. This is achieved by using the difference of the GMs of the original and the reblurred images as feature vectors to train extreme learning machine (ELM) to estimate the PSF parameters respectively. Further, a novel method that uses a cascaded digital filters operating as subtractors is proposed to transform the image from Geometric moment domain to spatial domain. The effectiveness of the proposed method of estimating the PSF parameters is examined using cross database validation. The results show that the proposed method in most of the cases performs better than the three existing methods when examined in terms of the visual quality evaluated using Structural similarity (SSIM) index.

Keywords: Learning machine, Image restoration, Digital Filters, Geometric moments.

1. Introduction

A typical image restoration task can be casted as a linear inverse problem as

$$\mathbf{g} = \mathbf{H}\mathbf{f} + \mathbf{n} \tag{1}$$

where $\mathbf{H} \in \mathbb{R}^{n^2 \times n^2}$ is a two dimensional blurring matrix where the elements are taken from the point spread function (PSF) $h(x, y)$, $\mathbf{f} \in \mathbb{R}^{n^2}$ is an original image of size $n \times n$, $\mathbf{g} \in \mathbb{R}^{n^2}$ is the degraded image and $\mathbf{n}$ is usually additive Gaussian white noise. When $\mathbf{H}$ is an identity matrix, the problem is define as image denosing; when $\mathbf{H}$ is is digonal matrix with elements 1 or 0, the problem is casted as image inpainting; when $\mathbf{H}$ is a Gaussian blur mask, problem becomes image deblurring. In this paper, we focus on problem of image deblurring. Image deblurring is an inverse problem where the objective is to recover a sharp image from its degraded version affected due to various