Chapter 13
Variable Length PSO-Based Image Clustering for Image Denoising

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ABSTRACT

This chapter proposed a variable length Particle Swarm Optimization based image clustering technique for restoration of noises from digital images. Here in this two step noise restoration technique the noise free pixels are kept unchanged. The denoising technique uses 3 × 3 test window on the center pixel of the noisy image. Prior to detection and filtering, variable length PSO based image clustering has been done. The output of clustering determines the performance of the subsequent stages of the algorithm. For denoising weighted median filtering technique is proposed. Variable length particles are considered and randomly encoded for the initial population. The length of particles is changed by adding and/or deleting cluster centers present in the particles. Three evaluation criteria are used in the fitness function of the proposed algorithm. The performance of the proposed algorithm is compared with some similar algorithms existing in the literature on several standard digital images.

INTRODUCTION

In various fields such as medical, satellite, underwater, robot vision, etc., digital image processing plays an important role. Denoising is a primary preprocessing performed by almost all image analysts because digital images can be contaminated during its acquisition or storage or transmission. There are several

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types of impulsive noise based on their characteristics. One of the most important impulsive noises is Salt and Pepper Noise (SPN) which degrades the original image by replacing some pixels with maximum or minimum intensity values of the image. Another noise type is Random Valued Noise (RVN) which replaces some pixels with a random value from the intensity range of the image. Traditional filters are common methods for image restoration in digital images (Gonzalez and Woods, 2002). An efficient method of noise reduction is simple median filtering, but only smoothing or simple median filters are not enough for removing the impulses, especially when they are highly corrupted. It is also difficult to preserve the fine details and textures of image such as edges and dots during their restoration. Simple median filters (Brownrigg, 1984) perform well but removes thin lines and dots, distorts the edges and blurs image fine textures even at very low noise density. The "weighted median (WM) filter" (Yli-Harja, Astola & Neuvo, 1991), "center weighted median (CWM) filter" (KO and Lee, 2001) and "adaptive center weighted median (ACWM) filter" (Chen & Wu, 2001) are improved median filters. Two step noise removal operators (also known as switching filters) (Sun & Neuvo, 1994) operate by using an impulse detector prior to filter the noises. An iterative "pixel-wise modification of MAD (PWMAD) (median of the absolute deviations from the median) filter" (Crnojevic, Senk & Trpovski, 2004) is a robust estimator of the variance used to separate noisy pixels from the image details. "Tri-state median (TSM) filter" (Chen, Ma & Chen, 1999) and "multi-state median (MSM) filter" (Chen & Wu, 2001) are used when there exist an appropriate number of center weighted median filters. The "progressive switching median filter (PSM)" (Wang & Zhang, 1999) does the noise detection and filtering iteratively. The "signal-dependent rank ordered mean filter (SD-ROM)" (Abreu, Lightstone, Mitra & Arakawa, 1996) is a switching mean filter which makes use of rank order information for noise detection and filtering purposes. A "directional weighted median filter" (Dong and XU, 2007) is proposed to remove Random Valued Noise (RVN) in the digital images. It works well however the computational complexity is high. The "second order difference based impulse detection" method developed by Sa, Dash and Majhi (Sa, Dash & Majhi, 2009), utilizes 3×3 window to detect and filter the Random Valued Noise in the image. It does not perform well when the digital images have high density of noises. Another two switching median filters, "MWB" (Mandal and Sarkar, 2010) and "MDWMF" (Mandal & Sarkar, 2011) have also been proposed in the literature to remove Random valued noise. More noise removal operators proposed by Mandal and Mukhopadhyay are "Edge Preserving Restoration of Random Valued Impulse Noise (EPRRVIN) filter", "Variable Mask Median (VMM) filter" and "GA based Denoising of Impulses (GADI)" filter, (Mandal & Mukhopadhyay, 2011, 2012). These filters obtain excellent restoration results when they are applied to images corrupted with random valued noise. Other filters based on soft computing tool are also devised such as "fuzzy filter" (Russo & Ramponi, 1996), "neuro fuzzy filter" (Kong & Guan, 1996) to remove impulses from the images.

Some of the most recent techniques, which can operate on all type impulses are "fast and efficient decision based algorithm for removal of high-density impulse noises (EDBA)" (Srinivasan and Ebenezer, 2000), "an improved decision based algorithm for impulse noise are removal (IDBA)" (Nair, Revathy & Tatavarti, 2008; Nair, Revathy & Tatavarti, 2008), "a switching median filter with boundary discriminative noise detection for extremely corrupted images (BDND)" (Ng and Ma, 2010), "a directional switching median filter using boundary discriminative noise detection by elimination (BDNDE)" (Nasimudeen, Nair & Tatavarti, 2010) and "a fuzzy-based decision algorithm for high-density impulse noise removal (FBDA)" (Nair & Raju, 2009). The EDBA operator consumes less execution time and preserves the edges but loses smooth transitions within the pixels. To resolve this problem, IDBA has been devised

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