Fuzzy random impulse noise reduction method

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Abstract

A new two-step fuzzy filter that adopts a fuzzy logic approach for the enhancement of images corrupted with impulse noise is presented in this paper. The filtering method (entitled as Fuzzy Random Impulse Noise Reduction method (FRINR)) consists of a fuzzy detection mechanism and a fuzzy filtering method to remove (random-valued) impulse noise from corrupted images. Based on the criteria of peak-signal-to-noise-ratio (PSNR) and subjective evaluations we have found experimentally, that the proposed method provides a significant improvement on other state-of-the-art methods.

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1. Introduction

Fuzzy techniques have already been applied in several domains of image processing e.g. filtering, interpolation [29] and morphology [18,19]. They also have numerous practical applications (e.g., in industrial and medical image processing [20,3]). A major problem of many image processing techniques is that they cannot work well in a noisy environment, so that a preprocessing module became necessary. In this paper, we will focus on fuzzy techniques for digital image filtering. More specifically we will concentrate on a fuzzy logic approach for the enhancement of images corrupted with impulse noise. Images are often corrupted with impulse noise due to a noisy sensor or channel transmission errors. The main goal of impulse noise reduction methods is to suppress the noise while preserving the fine texture and edge elements. Nonlinear techniques have been found to provide more satisfactory results in comparison to linear methods.

A number of nonlinear approaches have been already developed for impulse noise removal, for example the well-known fuzzy inference rule by else-action filters (FIRE). These filters try to calculate positive and negative correction terms in order to express the degree of noise for a certain pixel. We distinguish three FIRE filters: the normal FIRE from [23], the dual step FIRE from [24] (DS-FIRE) and the piecewise linear FIRE from [21] (PWLFIRE). The adaptive weighted fuzzy mean filter [17,16] (AWFM), the histogram adaptive fuzzy filter [30,31] (HAF), the intelligent image agent based on soft-computing techniques [8] (IIA) and the adaptive fuzzy switching filter (AFSF), which uses the

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5. Conclusion

A new fuzzy random impulse noise reduction method (FRINR), which consists of two fuzzy detection methods and a fuzzy filtering algorithm, has been presented in this paper. This filter is especially developed for reducing all kinds of random valued impulse noise (which is more realistic than the salt and pepper noise). Its main advantage is that it removes impulse noise very well while preserving the fine image structures. Additionally, we have constructed the filter so that no parameters have to be chosen by the user. Experimental results have shown the feasibility of the new filter. A numerical measure, such as the PSNR, and visual observations (Fig. 5 and 6) have shown convincing results for grayscale images.

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References


