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Hybridization of Algorithm for Restoration of Impulse Noise Image

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Abstract

In today's era, mainly communication is done through visual communication. Almost all information is transmitted in the form of digital image or video. But after transmission, the obtained information is often corrupted with noise. At a high noise density, detail information of the image is hidden by noise. Hence, we have to recover the original image by removing noise of the image without loss of data. Here, we proposed two hybridization methods, to yield better restoration of impulse noise images. The first proposed algorithm has hybridization of Decision Based algorithm along with 2D discrete wavelet transform. In second, hybridization of Decision based algorithm with Adaptive Wiener Filter. Experimental results in Figs. 3–6 shows that proposed algorithm 1 outperform in terms of visual quality till 80% of noise density. Proposed algorithm 2 also performs excellent in term of visual quality, but within noise density ranges from 70% to 90%. Even at 95% noise density, proposed algorithm 2 gives an improvement in PSNR value from 5.29 dB to 18.98 dB. Mean Absolute Error, Mean Square Error, Peak Signal to Noise Ratio and Image Enhancement Factor are calculated and the comparative study is made between Standard Median Filter, Cascaded decision based algorithm proposed in[10], and proposed algorithm.

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Keywords: Adaptive wiener filter; Decision based algorithm; Discrete wavelet transform; Impulse noise.

1. Introduction

Images are corrupted by noise during transmission of information through the channel or due to the faulty switching acquisition device. Noise can also be appears on the image due to the low quality sensing element, such as malfunctioning of imaging sensor and by environmental ambience. Noise is present in the form of Gaussian, Rayleigh, Gamma, Exponential, Uniform, Impulse or combination of more than one. Image restoration is an important pre-processing technique, which can be used before performing any subsequent task such as, image segmentation, image compression and object recognition. In this paper, we are concentrating on restoring the image from an impulse noise. Salt & pepper noise is another name of impulse noise, as it is characterized by relatively high (salt) or low (pepper) intensity value, compared to the neighbouring elements. Spatial filtering is a technique, used to restore the degraded image, i.e. operation is directly performed on an element and its neighbourhood elements within a rectangular mask. The filtering process applies on each mask. It starts from top left element as the corner of starting mask, and then moved on to next element and so on, as to cover the entire image and get the restored image. Mainly, two types of spatial filtering are used, i.e. linear filtering and nonlinear filtering. Arithmetic mean filter is a basic

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linear filter, which results in blurs along with a reduction in noise. Median Filter is a basic nonlinear filter, which gives excellent impulse noise reduction capabilities and also preserving fine detail with considerably less blurring than that of the linear arithmetic mean filter. Median filter is the simplest technique as it replaces each and every element of the image by a median of its neighbourhood intensity, regardless of whether it is noise or noise free[1]. Median filter is an effective technique, used to get the quality of restored image, but only at low noise density. However, median filter is most popular among nonlinear filter for removing impulse noise with its high computational efficiency. It does not provide good job at high noise density, as it's smoothing away from discontinuities. Since, the majority of elements in the smoothing area come from the background distribution, so the α – trimmed mean or weighted median are used to round the sharp corner[2]. In order to control the filtering operation in Weighted Median (WM) filter, selected elements are assigned with weights. Even this filter also processed on each and every element of an image, though the element is noise or noise-free, similar to that of the median filter. At moderate and high noise density, the restored image often exhibits blurring for larger mask size and distorted features for small mask size. In order to avoid the problem of applying filtering on all elements of an image, though it is noise or noise-free, the process is divided into two phases, impulse noise detection followed by filtering on noise elements[3–11]. In[3] for detecting impulse noise, boundary discriminative noise detection technique is used, where element is classified into three groups, lower intensity value, higher intensity value and middle intensity value. The lower and higher intensity values are considered as corrupted element and being processed by switching median filter. While middle intensity values are considered as uncorrupted, and remain unchanged. In[4–7] different direction based noise detectors are used to get the correct estimate of impulse element.These are based on correlation between processing element with its neighbours aligned directions. Only corrupted elements are processed by any type of median filtering. Adaptive Weighted Mean Filter technique is also used to remove the impulse noise, but it needs thresholding to set the proper size of mask[8]. To overcome this thresholding,[9–11] Decision Based Algorithm (DBA), Decision Based Unsymmetrical Trimmed Median Filter (DBUTMF), Modified Based Unsymmetrical Trimmed Median Filter (MBUTMF) andCascaded Decision based algorithm[10] are proposed, where only noisy element being processed by either median or neighbourhood processed element within a fixed rectangular mask. But at high noise density, most of the elements in the mask are noisy, and then the centre processing element is replaced by neighbourhood processed element and not gets good visual quality. Hence, we combine the decision based algorithm with other restoration techniques to have better visual quality and its parameter. In the past, discrete wavelet transform and Adaptive Wiener filter are used as restoration techniques, used for removing Additive White Gaussian noise[12].

Here, we will use this restoration technique for removing salt and pepper noise along with the decision based algorithm. This paper proposed new hybridization technique, to recover the original image by removing salt and pepper noise from the noisy image. The visual quality of the degraded Lena image is improved by proposing algorithm 1 and 2 as shown in Fig. 2.

The rest of this paper is arranged as follows. Section 2 discusses about the proposed algorithm. Simulation results on different images are presented in Section 3. Finally, Section 4 concludes the proposed algorithm.

2. Proposed Method

Here, we had proposed two hybridization techniques to remove salt and pepper noise of a noisy image at moderate and high noise density. In both the techniques, first noisy image is passed through the decision based algorithm and then processed by another algorithm. Hence, the result of the decision based algorithm is then processed by discrete wavelet transform in proposed algorithm 1 and by adaptive wiener filter in proposed algorithm 2. Hence, first we will discuss the decision based algorithm. And then we will study how the result of the decision based algorithm is processed through discrete wavelet transform or adaptive wiener filter and get the improved restored image. The decision based algorithm is explained as,

2.1 Decision based algorithm (DBA)

The Decision based algorithm is applied to 3×3 rectangular mask on degraded image. Consider an image is of uint 8 class, with intensity ranges from 0 to 255. Here, 255 (Salt) and 0 (Pepper) are two noise elements. Here, we