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A Survey Report on Different RVIN Removal Technique

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***Abstract*— Noise is an important factor which when get added to an image reduces its quality and appearance. So in order to enhance the image qualities, it has to be removed with preserving the textural information and structural features of image. There are different types of noises exist who corrupt the images. Selection of the de-noising algorithm is application dependent. Noise removal from a contaminated image signal is a prominent field of research and many researchers have suggested a large number of algorithms and compared their results. The main thrust on all such algorithms is to remove impulsive noise while preserving image details. These schemes differ in their basic methodologies applied to suppress noise. Some schemes utilize detection of impulsive noise followed by filtering whereas others filter all the pixels irrespective of corruption. In this section an attempt has been made for a detail literature review on the reported articles and studies their performances through computer simulation. We have classified the schemes based on the characteristics of the filtering schemes of random valued impulse noise (RVIN) and described are below. At the end of paper, a comparative study of all these algorithms in context of performance evaluation is done and concluded with several promising directions for future research work.**

***Index Terms*— Noise, Textural information, Image de-noising algorithm, Random valued impulse noise, Fix valued impulse noise.**

INTRODUCTION

Preservation of digital images during the process of image acquisition or transmission has always been a very cumbersome task for researchers. In the field of image processing, digital images very often get corrupted by several kinds of noise during the process of image acquisition. The basic reasons are malfunctioning of pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel [1]. Images are often corrupted by the impulse noise, Gaussian noise, shot noise, speckle noise, etc. Preservation of image details and suppression of noise are the two important aspects of image processing. Generally impulse noise is classified into two types: the salt-and-pepper noise also known as the fixed valued impulse noise and the random-valued impulse noise. Here in this paper, we focus on random valued impulse noise (RVIN). Random Valued Impulse Noise generates impulses whose gray level value lie within a specific range. The random value impulse noise lies between 0 and 255 and it is very difficult to remove this noise. Salt and pepper noise is also known as fixed valued impulse noise producing two gray level values 0 and 255. Where 0 values belong to black and 255 belongs to white on the gray scale. It is generally reflected by pixels having minimum and maximum value in a grayscale image. Generally the basic idea behind image de-noising is the detection stage, which identifies the noisy and noise free pixels of the corrupted image, after that noise removal part removes the noise from the corrupted image under process while preserving the other important detail of image.

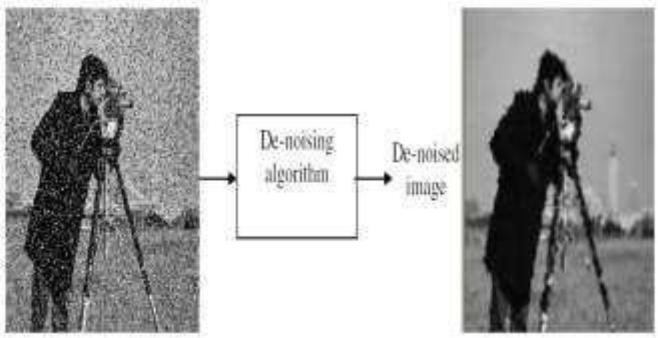

Figure 1. Image De-noising

There are two types of filters in spatial domain: linear filter and non-linear filter. Linear filters are like wiener filter, mean filter. Here we propose a nonlinear median filter which removes random valued noise and preserves the edges of the image.

Initially standard median filter was used, but later on switching based median filters were developed which provides better results. Any other result oriented standard median filters were developed, like weighted median filter, SDROM filter [8], Centre weighted median filter [14], adaptive median filter, rank conditioned rank selection filter [12] and many other improved filters. The consequences of median filter also depend on the size of filtering window. Larger window has the great noise suppression capability, but image details (edges, corners, fine lines) preservation is limited, while a smaller window preserves the details but it will cause the reduction in noise suppression. Noise detection is a vital part of a filter, so it is necessary to detect whether the pixel is noisy or noise free. Only noisy pixels are subject to de-noising and noise free pixels remains untouched.

NOISE MODEL

Two common types of the impulse noise are the Fixed-Valued Impulse Noise (FVIN), also known as Salt and-Pepper Noise (SPN), and the Random-Valued Impulse Noise (RVIN).

They differ in the possible values which noisy pixels can take [6]. The FVIN is commonly modeled by

$$(Y_{ij}) = \begin{cases} X_{i,j} & \text{with probabilty } p \\ (0,255) & \text{with probabilty } 1-p \end{cases} \quad \ldots\ldots\ldots\ldots(1)$$

Where x (i,j) and y(i,j) denote the intensity value of the original and corrupted images at coordinate (i,j), respectively and p is the noise density. This model implies that the pixels are randomly corrupted by two fixed extreme values, 0 and 255 (for 8-bit grey-scale images), with the same probability.

A model is considered as below:

$$(Y_{ij}) = \begin{cases} (0,m) & \text{with probabilty } p1 \\ X_{i,j} & \text{with probabilty } 1-p \\ (255-m,255) & \text{with probabilty } p2 \end{cases} \quad \ldots\ldots\ldots..(2)$$

Where p = p1 + p2. We refer to this model as Random valued Impulse Noise (RVIN).

CLASSIFICATION OF DENOISING ALGORITHMS

On the basis of Fig.-1, it is obvious that there are two basic approaches of image denoising, spatial filtering methods and transform domain filtering methods.

A. Spatial Filtering

A traditional way to remove noise from image data is to employ spatial filters. Spatial filters can be further classified into non-linear and linear filters.

1. Non-Linear Filters

With non-linear filters, the noise is removed without any attempts to explicitly identify it. Spatial filters employ a low pass filtering on groups of pixels with the assumption that the noise occupies the higher region of frequency spectrum. Generally spatial filters remove noise to a reasonable extent but at the cost of blurring images which in turn makes the edges in pictures invisible. In recent years, a variety of nonlinear median type filters such as weighted median [8], rank conditioned rank selection [9], and relaxed median [10] have been developed to overcome this drawback.

2. Linear Filters

A mean filter is the optimal linear filter for Gaussian noise in the sense of mean square error. Linear filters too tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise. The wiener filtering [11] method requires the information about the spectra of the noise and the original signal and it works well only if the underlying signal is smooth. Wiener method implements spatial smoothing and its model complexity control correspond to choosing the window size. To overcome the weakness of the Wiener filtering, Donoho and Johnstone proposed the wavelet based denoising scheme in [12, 13].

B. Transform Domain Filtering

The transform domain filtering methods can be subdivided according to the choice of the basic functions. The basic functions can be further classified as data adaptive and non-adaptive. Non-adaptive transforms are discussed first since they are more popular.

1. Spatial-Frequency Filtering

Spatial-frequency filtering refers use of low pass filters using Fast Fourier Transform (FFT). In frequency smoothing methods [11] the removal of the noise is achieved by designing a frequency domain filter and adapting a cut-off frequency when the noise components are deco related from the useful signal in the frequency domain. These methods are time consuming and depend on the cut-off frequency and the filter function behavior. Furthermore, they may produce artificial frequencies in the processed image.

LITERATURE REVIEW

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Yiqiu Dong, Raymond H. Chan, and Shufang Xu, **"A Detection Statistic for Random-Valued Impulse Noise" [19].** This paper proposes an image statistic for detecting random-valued impulse noise. By this statistic, we can identify most of the noisy pixels in the corrupted images. Combining it with an edge-preserving regularization, we obtain a powerful two-stage method for denoising random-valued impulse noise even for noise level as high as 60%. Simulation results show that our method is significantly better than a number of existing techniques in terms of image restoration and noise detection. In this paper, we propose a new local image statistic ROLD, by which we can identify more noisy pixels with less false-hits. We combine it with the edge-preserving regularization in the two-stage method to get a powerful method for removing random-valued impulse noise. Simulation results show that our method outperforms a number of existing methods both visually and quantitatively.

Umesh Ghanekar, Awadhesh Kumar Singh, and Rajoo Pandey, **"A Contrast Enhancement-Based Filter for Removal of Random Valued Impulse Noise" [16].** This paper presents a new filtering scheme based on contrast enhancement within the filtering window for removing the random valued impulse noise. The application of a nonlinear function for increasing the difference between a noise-free and noisy pixels results in efficient detection of noisy pixels. As the performance of a filtering system, in general, depends on the number of iterations used, an effective stopping criterion based on noisy image characteristics to determine the number of iterations is also proposed. Extensive simulation results exhibit that the proposed method significantly outperforms many other well-known techniques. In this paper, a filtering scheme to remove random-valued impulse from noisy images is presented. The detection of noisy pixels is based on the iterative applications of a nonlinear function that progressively increases the gray level separation between noisy and noise-free pixels. The performance of the proposed scheme, has been compared with many existing techniques. The efficiency of the proposed method is demonstrated by extensive simulations. The experimental results exhibit significant improvement in the performance over several other methods. Also, the proposed method requires fewer iterations in comparison with some recently proposed methods.

Ali S. Awad, **"Standard Deviation for Obtaining the Optimal Direction in the Removal of Impulse Noise"** [17]. This paper proposes a new technique of restoring images distorted by random-valued impulse noise. The detection process is based on finding the optimum direction, by calculating the standard deviation in different directions in the filtering window. The tested pixel is deemed original if it is similar to the pixels in the optimum direction. Extensive simulations prove that the proposed technique has superior performance, when compared to other existing methods, especially at high noise rates. In this paper, a new algorithm is proposed for removing random-valued impulse noise. The proposed approach is based on finding the optimal direction that is considered as a measure to indicate whether the tested pixel is noisy or noise-free pixel. In the sense that any pixel has small deviations with the pixels in the optimal direction is deemed as an original pixel. It is apparent that this approach surpasses others in terms of PSNR and visual image quality, particularly at high noise rate.

Bo Xiong and Zhouping Yin, **"A Universal Denoising Framework with a New Impulse Detector and Nonlocal Means" [21].** Impulse noise detection is a critical issue when removing impulse noise and impulse/Gaussian mixed noise. In this paper, we propose a new detection mechanism for universal noise and a universal noise-filtering framework based on the nonlocal means (NL-means). The operation is carried out in two stages, i.e., detection followed by filtering. For detection, first, we propose the robust outlyingness ratio (ROR) for measuring how impulse like each pixel is, and then all the pixels are divided into four clusters according to the ROR values. Second, different decision rules are used to detect the impulse noise based on the absolute deviation to the median in each cluster. In order to make the detection results more accurate and more robust, the from-coarse-to-fine strategy and the iterative framework are used. In addition, the detection procedure consists of two stages, i.e., the course and fine detection stages. For filtering, the NL-means are extended to the impulse noise by introducing a reference image. Then, a universal denoising framework is proposed by combining the new detection mechanism with the NL-means (ROR-NLM). Finally, extensive simulation results show that the proposed noise detector is superior to most existing detectors, and the ROR-NLM produces excellent results and outperforms most existing filters for different noise models. Unlike most of the other impulse noise filters, the proposed ROR-NLM also achieves high peak signal-to-noise ratio and great image quality by efficiently removing impulse/Gaussian mixed noise. The main contribution of this paper can be summarized as follows: introduce new statistics ROR for describing the outlyingness of the pixels and propose a new detection mechanism; extend the NL-means to the impulse noise; and obtain a universal noise removal framework with the proposed detection method and the NL-means. The proposed approach can be adapted to various models such as salt-and-pepper impulse noise, random-valued impulse noise, and mixed noise by modifying some parameters in the algorithm. Extensive simulations reveal that the performance of the proposed algorithm is good. However, there are still some problems in the algorithm, and we will focus on these problems in future research.

Muhammad Waqas, Syed Gibran Javed and Asifullah Khan, "**Random-valued Impulse Noise Removal from Images: K-means and Luo-Statistics based Detector and Nonlocal Means based Estimator" [00].** Impulse noise detection is the key issue, while removing random-valued impulse noise from digital images. In this paper, we present a new impulse detection algorithm based on combination of Luo-statistic and k-means clustering. This paper also presents a novel approach to measure impulse noise density level in the corrupted image, knowledge of which allows us to select suitable parameters for the noise detection algorithm. In noise filtering stage, we apply nonlocal-means (NL-means) estimator to restore noisy pixels to their actual values. Extensive experimental results show that the proposed method outperforms most of the existing impulse noise removal techniques both in terms of noise detection and image restoration. This paper presents a novel three-stage impulse noise filter, called the Luo-Kmeans-NLM filter. The proposed filter utilizes a combination of Luo-statistic and k-means clustering algorithm to obtain an impulse detector, which adaptively adjusts thresholds for noise detection, for images of varying texture and brightness. The use of NL means estimator at filtering stage significantly improves the quality of restored image. The empirical results shown, advocate the usefulness of the proposed filter for denoising images corrupted with smaller as well as larger noise ratios.

COMPARATIVE ANALYSIS

De-noising performances are quantitatively measured by the PSNR and MAE as defined in equations (1) and (2) respectively:

The PSNR and MSE (Mean Square Error) cab be expressed as:

$$PSNR = 10\ log_{10} \frac{(255)^2}{(MSE)} \qquad 1$$

$$MSE = \frac{\sum_{i=1}^{m} \sum_{j=1}^{255} \{Y(i,j) - \hat{Y}(i,j)\}^2}{m \times n} \qquad 2$$

CONCLUSION

This paper review different techniques to remove random valued and fixed valued impulse noise. There are many methods that perform well for salt and pepper noise but fail for random impulse noise. In this paper, we have discussed different methods for impulse noise detection and removal. In this review we have seen that there are different methods for image de-noising but also want to enhance the quality of images. In the case of digital image processing removal of impulse noise is important but also focuses on image enhancements like edge preservation and other quality of images. Further we will proposed a new method for a removal of impulse noise as well as enhance the quality of images also.

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