A Review On image De-noising Techniques in Image Processing

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ABSTRACT

Image processing is a way to convert an image into digital form and perform some operation on it to obtain some useful information from it. The main aim of image processing is to visualization, image sharpening and restoration, image retrieval, measurement of pattern, image recognition. In Digital Image Processing, the images are more prone to noise due to image capture and transmission The image obtained after transmission is often corrupted with different types of noise. Digital images are contaminated by various types of noises such as Gaussian, Speckle and Impulse noise. In this survey different types of noises, degradation and restoration Model are discussed. We also give a brief introduction about different types of filtering algorithms such as Mean filter, Median filter and Adaptive filters to reduce noise present in the digital image.

Keyword:- *Image De-noising, Image Processing, edge preservation.*

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1. INTRODUCTION

What is a noise?

Noise means unwanted modification in the signal during capture, storage, transmission, processing or conversion. Image is corrupted by blurring effect or by noise too. The image captured after transmission is often corrupted with noise. The original meaning of "noise" was and remains "unwanted signal"; unwanted electrical fluctuations in signals received by AM radios caused audible acoustic noise ("static")..

By analogy unwanted electrical fluctuations themselves came to be known as "noise". Image noise is, of course, inaudible. The magnitude of image noise can range from almost imperceptible specks on a digital photograph taken in good lighting, to optical and radio astronomical images that are almost entirely noisy, from which a small amount of information can be derived by sophisticated processing(a noise level that would be totally unacceptable in a photograph since it would be impossible to determine even what the subject was).

From where it is originated?

Image noise is random (not present in the object images) variation of brightness or colour information in images, and is usually an aspect of electronic noise. It can be produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Image noise is an undesirable by-product of image capture that adds spurious and extraneous information.

Use of filters in removing noise-

- In the transmission, digital images often disturbed by various interferences, leading to the image corrupted severely.
- For the better visual quality and further use in digital image processing systems, noises must be removed.
- In signal processing a filter is a device or process that removes some unwanted components or features from a signal.
- Filtering is a class of signal processing, the defining feature of filters being the complete or partial suppression of some aspect of the signal.

Image Processing is a field that continues to grow, with new applications being developed at an ever increasing pace. It is fascinating and an exciting area to be involved in today with application area ranging from the entertainment industry to the space program. One of the most interesting aspects of this information revolution is the ability to send and receive complex data that transcends ordinary written text. Visual information, transmitted in the form of digital images, has become a major method of communication for the 21st century. Image processing is a form of signal processing for which the input is an image such as photographs or frames of video and the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

Images are often degraded by unwanted signals called noise. Image acquisition and transmission are the two main steps involved in digital image processing during which noise is induced in an image. In every image processing algorithm, quality of image plays a vital role because the output of algorithm depends on the quality of input image. Several techniques are used for image quality enhancement and image restoration. Digital images are frequently damaged by impulse noise during the signal acquisition and data transmission. For the better visual quality and further use in digital image processing systems, noise must be removed as far as possible. The removal of noise in image also facilitates the following image processing, such as coding, pattern recognition, analysis or interpretation of performance. Thus, study on effective de-noising technologies is necessary for various image applications. Traditional linear filtering approaches cannot efficiently remove impulse noise due to the fact that both noisy and noise-free pixels are filtered, especially at higher noise density interference and for use in filtering random-valued impulse noise. Many efficient non-linear digital filters have been represented for removal of impulse noise in image processes, such as decision based algorithm and edge-preserving algorithm for filtering fixed-valued impulse de-noising processing. Some common techniques applied to all the images without having prior knowledge of noise and are called image enhancement algorithms. Therefore image enhancement is largely a subjective process whereas image restoration works on prior knowledge of the degradation process is almost an objective process. Noise removal techniques depends on the type of noises degrading the image and also largely on the percentage of noise corrupting the image. Impulse noise which may be a randomly distributed noise (uniform noise) is one of the most naturally occurring noises in digital images.

Digital images are actually playing an essential part of life. Being produced by a variety of devices, they are a key element of consumer, industrial, medical, scientific, military and other applications. However, imperfect acquisition instruments, natural phenomena or transmission errors, often distort the true intensity of the visual signal. The distortions include but are not limited to blurring, additive or multiplicative noise, non-uniform illumination and geometric distortion. They can heavily distort or even make impossible.

Image de-noising is a vivid research subject in signal processing because of its fundamental role in many applications. In particular some de-noising methods [2]typically assume that the true signal can be well approximated by a linear combination of few basis elements. That is, the signal can be sparsely represented in the transform domain. The multi resolution transform can achieve good sparsity for spatially localized details such as edges and singularities. Plenty of de-noising methods exist, originating from various disciplines such as linear and non-linear filtering[4].All these methods rely on some explicit or implicit assumptions about the true (noise free) signals in order to separate it properly from the random noise. In this work, we studied an adaptive fuzzy based weighted approach for the removal of random valued impulse noise for color images

2. LITERATURE REVIEW

Kh. M. Singh et al [1] An adaptive switching approach has been presented in which the detection of noise is based on entropy of the pixels. Then the detected noisy pixels are replaced with the output of a fuzzy weighted filter. With a little increase in computational complexity over the basic vector median filter and its varieties, this technique works well both in lower and higher noise ratios. This technique can also be extended for images corrupted with Gaussian noise and mixed Gaussian and Impulse noise. As in this switching filter, experiments on a set of two images show that the filter might be very close to some of the robust filters in lower noise ratio in terms of preserving the signal content, but it definitely outperformed them. Simulation results show that this method outperforms many other existing nonlinear filters in terms of noise reduction and fine details preservation. This filter not only preserves the image's details efficiently but also maintains the chromaticity of the colour image very well.

Future work will be in introducing a nonlinear function over fuzzy weighted pixels instead of simply taking the average.

T.K et al [2] proposed a new approach for impulsive noise removal from images. In other words, we can say to suppress noise from the corrupted images. It uses the sparsity of natural images when they are expanded by mean of a good learned dictionary. Before giving a brief introduction about this method, we must know what sparse or sparsity actually meanssparsity refers to scattering. The zeroes in the sparse domain give us an idea to reconstruct the pixels that are corrupted by random-valued impulse noise. Actually this idea came from the reality that noisy image in sparse domain of the original image will not have a sparse representation as much as original image sparsity. This method was accomplished in two steps: first, we use the boundaries proposed in BDND (Boundaries discriminating noise detection) method to find the location of impulse noise and to form a soft-decision mask. This mask indicates to the user which pixels are corrupted and which is not. In the second step, by using the obtained mask and iterative approach, method is implemented according to the sparse component analysis foundation and then image is reconstructed.

Pankaj Kr. Seat al [3] various efforts have been made for highly corrupted images. A new method is proposed i.e. MWB (Modified Weighted based) filter which is based upon the weighted difference with its current pixel and its neighbors aligned with four main directions. This filter makes full use of the impulse to detect and restore noise.
Simulations showed that this filter provides optimal performances of suppressing impulse with high noise level which may enhance the performance. Simulations also showed that this filter performs much better than many existing median-based filters in both subjective and objective (PSNR) evaluation. Especially on some specific corrupted images, the proposed filter (MWB) gives better embedded images than that of the DWB filter. Since PSNR shows the ratio between the maximum possible powers of the signal to that of the corrupted noise, hence higher the PSNR, better is the quality of the image.

A.S.Awad et al [4] A new filtering scheme has been presented based on the contrast enhancement within the filtering window for removal of random-valued impulse noise.The application of the non-linear function for increasing the difference between noisy pixel and a noiseless one results in efficient detection of noisy pixels. As the performance of the filtering system, in general, depends upon the number of iterations used. So, the detection of the noisy pixels depends upon the iterative applications of a non-linear function that progressively increases the gray scale level between noisy and noiseless pixels. The performance of the proposed scheme has been compared with many existing noise detection techniques. The experimental results exhibit significant performance or better efficiency over several other techniques.

M.E.Yuksel et al [5] A two stage image filtering scheme has been proposed using neuro-fuzzy impulse detector. In the first stage, adaptive neuro-fuzzy system (ANFIS) based impulse noise detector is used to locate the noisy pixels while in the second stage, improved vector median filter is used to provide the correct value of the corrupted pixel. The filtering stage changes the pixels in the image when found corrupted by the noise. Simulation results indicate that the proposed scheme performs much better than other variants of vector median filter. For quantitative measurements PSNR peak signal to noise ratio is used for error in luminance values and normalized color difference (NCD)is used to measure the error in chrominance values of the image.

M.Habib et al [6] This method based upon four most similar neighbors (MSN) which considers all the pixels of the sliding window except the central pixel after taking the first order absolute differences from the central pixel. This approach is a two-step process-noise detection followed by filtering. Noise detection is relied on fuzzy interference system, fuzzy rules, and adaptive threshold while restoration is based on fuzzy based median filter. For noise detection, first order absolute differences are calculated and then sorted them in ascending order. Clusters of equal sizes are formed based on most similar pixels and fuzzy rules are applied to detect the presence of noise in the current pixel. Threshold parameters are set adpatively by utilizing the most similar neighbors around the current pixel. In filtering phase, median based fuzzy filter is used to restore the corrupted pixel This filter gave admirable PSNR on practical noise up-to 30% with window size N=1.

Tzu-Chao Lin et al[7] A fuzzy preservation-based total variation filter (FPTV) has been proposed for removal of random-valued impulse noise. In this de-noising scheme, adaptive center weighted median filter (ACWMF)is used to employ the variable window sized technique to improve its detection ability especially in highly corrupted images. The filter(ACWMF) not only checks whether a pixel is noisy or not but it also renders the confidence

coefficient(CF)for each pixel to check its potential to be an impulse Then a function is designed with noise level p and CF as its arguments to determine pixel-wise the trade off between smoothness term and the data fidelity term in total variation energy functional. After minimizing the energy functional, we obtain the restored image.
Simulation results showed that it outperformed some representative algorithms, both in vision and quantitative measurements like peak signal-to-noise ratio (PSNR) and mean absolute error (MAE).

C.C.Lien et al[8] An efficient de-noising scheme for impulse noise has been proposed. The proposed scheme estimated noisy or noisy-free for the detected pixel in terms of the most probable edge of the 3*3 window. Then the detected pixel is replaced by the median value of the most probable edge, if it is noisy.
The proposed scheme efficiently removed fixed-valued and random-valued impulse noise sources while preserving image edges. It has better image quality than those of the conventional linear and non-linear filters. The proposed scheme also maintained the edge of the restoration image due to preserving image edge details. Because of its simple procedure, it is suited for real-time applications and hardware implementation.

A.Royet al [9] Artificial neural network (ANN) based fuzzy filter has been proposed for the removal of random impulse noise from gray scale images. ANN is used for classification of noisy and noise free pixels from the images corrupted by impulse noise. Fuzzy filter is incorporated in the system for filtering of impulse noise.
This method increases peak signal-to-noise ratio (PSNR) not only for low noise density but also for high noise density. This method maintains structural similarity of the original image from that corrupted one to a great extent. It reduces computation time of the removal process while removing noise from the corrupted image. This proposed method worked better for the images corrupted with impulse noise even if the train image is different from the tested one.

P.Zhang et al [10] An efficient approach has been proposed to restore image corrupted by high-density impulse noise i.e. Median filtering technique. First, the proposed method detects both the number and position of the noise-free pixels in the image. Next, the dilation operation of the noise-free pixels based on morphological image processing is iteratively executed to replace the neighbor noisy pixels until convergence.
By this, the method is able to remove the high-density noise and therefore reconstruct the noise-free image. This filter method consumes only moderate execution time while producing the highest quality restored images and possessing the highest PSNR values.

X.Zhang et al[11] A novel de-noising method has been proposed, which is based on the decision-tree and edge-preserving techniques for the removal of random-valued impulse noise. In this approach decision-tree based detector is used to detect the noisy pixel and an effective design is employed to locate the edges.
Extensive experimental results showed that the proposed technique not only preserved the edge features, but also obtained excellent performance in terms of quantitative evaluation and visual quality. Furthermore, the design requires very low computational complexity and suitable for real-time embedded systems. This technique worked with monochromatic images, but it can be extended for working with RGB color images and videos.

V.Jayaraj et al[12] An approach has been proposed in which double median filtering stage is used to preserve edge details which enhance the quality of image, while keeping the image details preserved and it is one of the most important issue. The algorithm is carried out in two stages- first is the detection stage in which noisy pixel is detected and the other one is filtering stage in which median is calculated twice or noisy pixel is replaced by median value. The goal of proposed algorithm is to remove high-density noise in digital images while keeping edge information preserved. Results of the proposed technique have been analysed in terms of visual quality and quantitative results. The proposed work gave better image qualities in terms of high peak signal to noise ratio PSNR and reduced minimum square error MSE.

Chan R.H et al [13] An improved decision-based detail preserving variation method(DPCM)has been proposed for removal of random valued impulse noise.The ability of noise removal and restoring speed are the main improvements in the algorithm. The more suitable window type rather than the fixed square window is used to detect noise in this technique. This modification made the number of undetected noisy pixels decrease greatly. By consideration of distribution of random valued impulse noise and difference between noisy pixel and its neighbor, noise candidates are classified and different values marked them by using an iteration scheme based on improved adaptive center weighted median filter(ACWMF).Then these noise marks guide the restoration algorithm to change the weight adaptively. More importantly, the weight-adjustable DPCM implemented only once to restore all the

noise candidates. Besides the restored images are better in terms of PSNR and visual quality than those obtained by other methods..

PrateekBansal et al [14] In this approach, local area comprises within the window in an image is analysed for intensity extreme to classify the pixel as either noisy or noiseless. Filtering is applied to the noisy pixels only and it is done in such a way that it can be replaced by either the median or mean value of the filtering window depending on the noiseless pixels present in the window. The proposed technique tested on a large numaber of gray-scale and color images under a wide range of noise density(from 10% to 94%) and the simulation results showed that it performed better in terms of suppressing impulse noise while preserving image details.

Bodduna K et al [15] proposed an efficient way to remove the random-valued impulse noise and edge-preserving regularization of the obtained image. In this, a two phase mechanism is followed where the noisy pixels in the interior region are dealt with first and those in the outer regions later. Simulation results showed computational efficiency and image restoration capacity. It maintained a great balance between both of them. Promising results were found even for noise levels as high as 60% with the proposed algorithm.

V.R. Vijaykumar et al[16] A novel decision based adaptive median filter has been proposed to remove blotches, scratches, streaks, stripes and random valued impulse noise in the images. It is a two stage algorithm. In the first stage, noise candidates are detected using rank ordered absolute difference (ROAD)value while in the second stage, replacement is done by median of the uncorrupted pixels in the filtering window. The filtering window is varied adaptively based on the number of uncorrupted pixels in the window. The proposed technique is very effective in removing random valued impulse noise up to a noise density as high as 60%.The main advantage of the proposed work is easy to implement in hardware and fast execution time.

P.-Y. Chan et al[17]An efficient de-noising scheme and VLSI architecture has been proposed to remove random - valued impulse noise. A low-complexity VLSI architecture is proposed to achieve the goal of low cost. A decision-tree based impulse noise detector is designed to detect the noisy pixel and an edge-preserving filter to reconstruct the intensity values of the pixels. Experimental results showed that this technique achieved better performance in terms of quantitative evaluation and visual quality than other techniques. The VLSI architecture yielded a processing rate of 200MHz by using TSMC. This design required low computational complexity and two line memory buffers. Its hardware cost is low and can be applied to many real time applications.

K.Inoue, et al [18] An extended weighted median filter has been proposed to remove random-valued impulse noise with preserving detailed structures in a grayscale image. This filter combined the median filter with a square window and that with adaptive ones constructed by using 8-neighborhood minimum spanning trees(MST).
This proposed method calculated a weighted median by using the pixel both in the square window and the adaptive one which fits to a detailed structure in the image. The excellent performance of the proposed method was verified through a series of experiments.

Shanmugavadivu P et al [19]An enhanced method of image-de-noising has been proposed. The mathematical analysis showed that this process improves the (PSNR) peak signal-to-noise ratio at high density noise level. Two levels of threshold and improved median value remove the noise much effectively. This method has the following advantages:

- The median value is more accurate than other values.
- Reduces the delay and enhance the processing speed of filter with the help of parallel processing.
- Reduction in hardware complexity and ease of implementation.

K Shukla et al [20] Directional based similar nearest neighbor(DBSNNF)filter has been proposed which is capable of suppressing random value impulse noise while preserving fine image details. The proposed filter is dividing into two modules. First module detects direction indices of DWM filters for impulse noise detection and second module for estimating a value by considering characteristics of the neighbouring pixels.
Y.Zhou et al [21]Proposed a low-rank prior for small oriented noise-free image patches. The low-rank prior suggested that a single patch can be effectively de-noised within a low-rank matrix recovery framework. The single patch can effectively removed RVIN. Experimental results showed that the proposed method worked better than other methods, especially for other non-pointwise RVIN.

Ibrahim Pekkucuksen et al [22] An algorithm has been proposed to detect the noise and restore the image corrupted by reason valued impulse noise which employed Robust Direction Based Detection(RDD) for detection and edge strength interpolation for filtering respectively. RDD based upon ROR(Robust Outlyingness Ratio)and SD(Standard Deviation).Based on the ROR, the pixels are classified into noisy and noiseless pixels. The proposed algorithm preserved details at high noise densities and has a better performance than other algorithms.

Awadhesh Kumar Singh et al [23] A two-stage Noise Adaptive Fuzzy Switching Weighted Median (NAFSWM)for eliminating fixed-valued and random-valued impulse noises. This filter is able to suppress upto 90% of noise. It does it require any further tuning or training of parameters once optimized, preserving fine image details, edges and textures.

Chih-Yuah Lien et al [24]To improve the image ,two modifications has been proposed i.e.DTBID and EPIF concepts.The modifications imposed on the expanding window size and the macro block filtering concepts.The iterative median filter performance showed that the preserved edges and also removing random-valued impulse noise.

Manohar Koli et al [25] Modified adaptive median threshold filter has been proposed for color image random-valued impulse noise reduction. Firstly, the detection of impulse noise on the basis of maximum and minimum value of pixels in the small window. Secondly, removal of noise on the basics of median calculation. Experimental results showed that the proposed method is superior to the conventional methods in (PSNR) peak signal-to-noise ratio and (MSE)minimum square error.

In this world of advance technology, images have become a vital part in information exchange process. Digital images play an important role in today's multimedia content [1]. But these images get seriously affected by various types of atmospheric degradations which may occur due to environmental or human resources such as wind, temperature, pressure, lighting, hardware components of the transmitter and receiver, optical cables etc.it becomes difficult for the recipient to reveal the transmitted information if the images are affected by such degradations and it is necessary to enhance the degraded images. Various problems arise due to the presence of noise in the transmitted images and the type of noise added to the image. Sometimes, two types of noise signals get added to the image, thus demeaning the details. Figure 1 shows the effect of noise on real signals.

The essential issue is to eliminate the noise effectively thereby protecting the image details. There are certain factors due to which the image quality gets degraded; some of them are listed below.

CONCLUSIONS

The paper proposed that Image de-noising is a fundamental problem in image processing. Some of the recent and successful advances in the field are the methods considered in the literature survey. We see that the most recent method MDBUTMF (by PrateekBansal et al 2015) has better results in terms of suppressing impulse noise while preserving image details. Switching VMF (by Kh. M. Singh et al 2014) not only preserves the image's details efficiently but also maintains the chromaticity of the colour image very well. All the methods considered in survey have suppressed impulse noise at their best while some methods also have a computational complexity in algorithms. Future work includes adaption of new filtering schemes to suppress random-valued impulse noise in Color images which not only give better visual quality but also results in Edge Preservation.

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