HIGH DENSITY SALT AND PEPPER IMPULSE NOISE REMOVAL USING MODIFIED MEDIAN FILTER

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Abstract— ***Images are imitations of real world objects. Often an image is a two dimensional (2D) signal f(x,y) represent the amplitude or intensity of the image. In the Transmission of images, they are corrupted by salt and pepper noise, due to faulty communications. Salt and Pepper noise is also known as Impulse noise. The intention of filtering is to eradicate the impulses so that the noise less image is fully enhanced with slightest signal distortion. The best-known and most commonly used nonlinear digital filters, based on order statistics are median filters, also known as Simple Median Filter (SMF). Median filters are recognized for their capability to remove impulse noise without damaging the edges. Median filters are recognized for their capability to remove impulse noise as well as preserve the edges. The operative removal of impulse often hints to images with blurred and distorted features. Ideally, the filtering should be applied only to corrupted pixels while leaving uncorrupted pixels intact. Applying median filter unconditionally across the entire image as practiced in the conventional schemes would inevitably alter the intensities and remove the signal details of uncorrupted pixels. Hence, a noise-detection process to categorize between virtuous pixels and the degraded pixels prior to smearing nonlinear filtering is highly desirable. The main aim of this work is to modify the existing median filters and implement the modified median filter for reduction of high density impulse noise (salt & pepper noise). Then evaluate the performance of the algorithm using MSE & PSNR parameters.***

Keywords- Salt & Pepper Noise, Noise Removal, Image Filter, Median Filter, PSNR

I. INTRODUCTION

Computers are faster and more accurate than human beings in processing numerical data. However, human beings score over computers in recognition capability. The human brain is so sophisticated that we recognize objects in a few seconds, without much difficulty. We may see a friend after ten years, yet recognize him/her in spite of the change in his/her appearance as the method by which humans gather knowledge for recognition is very unique. Human beings use all the five sensory parts of the body to gather knowledge about the outside world. Among these perceptions, visual information plays a major role in understanding the surroundings. Other kinds of sensory information are obtained from hearing, taste, smell, and touch. The old Chinese proverb "A picture speaks a thousand words" rightly points out the images are very powerful tools in communication. With the advent of cheaper digital cameras and computer systems, we are witnessing a powerful digital revolution where images are being increasingly used to communicate ideas effectively [1].

We encounter images everywhere in our daily lives. We see many visual information sources such as paintings and photographs in magazines, journals, image galleries, digital libraries, newspapers, advertisement boards, television, and the internet. Images are virtually everywhere! Many of us take digital snaps of important events in our lives and preserve them as digital albums. Then through the digital album we print digital pictures and/or mail them to our friends to share our feelings of happiness and sorrow. However, images are not used merely for entertainment purposes. Doctors use medical images to diagnose problems for providing treatments. With modern technologies, it is possible to image virtually all anatomical structures, which is of immense help to doctors, in providing better treatment. Forensic imaging applications process fingerprints recognition, hand recognition, faces recognition, and irises to identify criminals. Industrial applications use imaging technology to count and analyze industrial components. Remote sensing applications use images sent by satellites to locate the minerals present in the earth. Thus, images find major applications in our everyday life.

During the transmission and acquisition, pixels gray values are affected by different type of noise present in medium. These noise can be Gaussian type or impulse noise. The most common type of noise which affects the image in the form of black and white dots is impulse noise. Image processing is an important area in the information industry. A crucial research is how to filter noise caused by the nature, system and processing of transfers and so on. Image de-noising is one of the most famous and widely studied algorithms in image processing and computer vision. There is need of having a very good image quality required with the use of the new technologies in a various fields such as multimedia technology, medical image enhancement, aerospace, video systems and many others.

The main objective of the work can be pointed as follows:

- To implement the modified median filter for reduction of high density impulse noise (salt & pepper noise).
- To evaluate the performance of the algorithm using MSE & PSNR.
- The result is verified for different input (reference & real) images.

II. LITERATURE REVIEW

Arabinda Dash et al. [1] (2015), an advanced non-linear cascading filter algorithm for the removal of high density salt and pepper noise from the digital images is proposed. The proposed method consists of two stages. The first stage Decision base Median Filter (DMF) acts as the preliminary noise removal algorithm. The second stage is either Modified Decision Base Partial Trimmed Global Mean Filter (MDBPTGMF) or Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) which is used to remove the remaining noise and enhance the image quality. The DMF algorithm performs well at low noise density but it fails to remove the noise at medium and high level. The MDBPTGMF and MDUTMF have excellent performance at low, medium and high noise density but these reduce the image quality and blur the image at high noise level. So the basic idea behind this paper is to combine the advantages of the filters used in both the stages to remove the Salt and Pepper noise and enhance the image quality at all the noise density level.

Chauhan et al. [2] (2015), in their paper "High Density Impulse Noise Removal based on Linear Mean-Median Filter"propose that used to reduce impulse noise. LMM filter is a combination of Mean and Median filter. Where, linear value is taken from the linearity between mean and median value. Both mean and Median filter are only used for noise-free pixel on the 3x3 windows that has been sorted from the smallest to the largest value. The average value is obtained from the average value of all noise-free pixels without taking into account the median pixel position. Meanwhile, median pixel value is the value of middle position of the pixel that has been sorted. LMM filter uses nine sample pixels value to determine a pixel for replacement a noisy pixel.

Fitri et al. [3] (2013), in their paper 'Visual Coherence Metric for Evaluation of Color Image Restoration' proposed a novel objective metric for assessing the quality of color image inpainting" describe that which takes into account some constraints and characteristics related to the specific objectives of inpainting approaches. The used characteristics are the visual coherence of the re- covered regions and the visual saliency describing the visual importance of the area. A series of psychophysical experiments have been conducted to evaluate the performance of the proposed image quality index.

Madhur S. et al. [4] (2012), in their paper "Image restoration for multiple copies: A GMM based" they have addressed the problem of utilizing multiple degraded observations of an image for better image restoration. They proposed an algorithm which utilizes the correlated information from all different observations to produce better reconstruction quality. Different experiments con- ducted to evaluate the performance demonstrates effectiveness of the algorithm in using correlation among multiple observations. Recovery of original images from degraded and noisy observations is considered an important task in image processing. Recently, a Piece-wise Linear Estimator (PLE) was proposed for image recovery by using Gaussian Mixture Model (GMM) as a prior for image patches.

Raza et al. [5] (2012), in their paper "The Image Restoration Method Based on Image Segmentation and Multiple Feature Fusion" they consider the local correlation of natural image, uses Mean Shift clustering segmentation algorithm to separate the original input image, limits the search scope in the related texture region to find the best matching block; at the same time for finding matching algorithm of the most suitable texture block, through the analysis of image texture feature, the structure characteristics and the distance between repair block and similar block, this paper puts forward a kind of texture similarity block matching algorithm based on texture, structure and the distance.

Jayaraj et al. [6] (2010), in their paper they proposed a fast and reliable median filter "A Fast and Reliable Median Filter for Extremely Corrupted Images", for de-noising extremely corrupted images by impulsive noise. A switching median filter with boundary discriminative noise detection (BDND) is very effective and outperforms all previously proposed median-based filters. However, it is very time-consuming in calculation. The proposed method uses similar scheme as in BDND, but it is much more reliable and faster than BDND method. The proposed method uses an efficient sorting algorithm both in noise detection and adaptive filtering stages. The performance of the proposed method is demonstrated through computer simulations in comparison with the BDND method.

III. Problem Formulation

To improve the interpretability or perception of information in images for human viewers, or to provide better input for other automated image processing techniques is the mail focus of image enhancement. It refers to accentuation, or sharpening, of image options like boundaries, or contrast to create a graphic show a lot of helpful for show & amp; analysis. This method doesn't increase the inherent info content in image. It includes grey level & amplitude; distinction manipulation, noise reduction, edge adjusting and sharpening, filtering, interpolation and magnification, pseudo coloring, and so on. Image enhancement can be sub divided in two categories:

1. Spatial domain methods, which operate directly on pixels.
2. Frequency domain methods, which operate on the Fourier transform of an image.

It is concerned with filtering the observed image to minimize the effect of degradations. Effectiveness of image restoration depends on the extent and accuracy of the knowledge of degradation process as well as on filter design. Image restoration differs from image enhancement in that the latter is concerned with more extraction or accentuation of image features.

The quality of such data representation is characterized by parameters such as data accuracy and precision. Data accuracy is the property of how well the pixel values of an image are able to represent the physical properties of the object that is being imaged. Data accuracy is an important parameter, as the failure to capture the actual physical properties of the image leads to the loss of vital information that can affect the quality of the application. While accuracy refers to the correctness of a measurement, precision refers to the repeatability of the measurement. In other words, repeated measurements of the physical properties of the object should give the same result. Most software use the data type "double" to maintain precision as well as accuracy.

Salt and pepper noise is an impulse type of noise, which is also referred to as intensity spikes. This is caused generally due to errors in data transmission. It has only two possible values, a and b. The probability of each is typically less than 0.1. The corrupted pixels are set alternatively to the minimum or to the maximum value, giving the image a "salt and pepper" like appearance. Unaffected pixels remain unchanged. For an 8-bit image, the typical value for pepper noise is 0 and for salt noise 255. The salt and pepper noise is generally caused by malfunctioning of pixel elements in the camera sensors, faulty memory locations, or timing errors in the digitization process.

IV. Proposed Methodology & Algorithm

The main challenge in research is to removal of impulsive noise as well as preserving the image details. Our schemes utilize detection of impulsive noise followed by filtering. In the filtering without detection, a window mask is moved across the observed image. The mask is usually of size (2N +1)2, where N is a positive integer. Generally the Centre element is the pixel of interest. When the mask is moved starting from the left-top corner of the image to the right-bottom corner, it performs some arithmetical operations without discriminating any pixel.

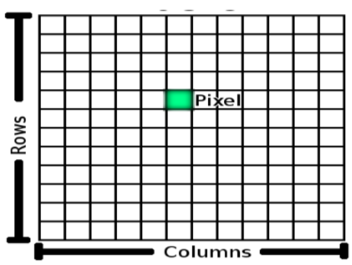

Figure 1: Neighborhoods of a Central Pixel (x, y)

Detection followed by filtering involves two steps. In first step it identifies noisy pixels and in second step it filters those pixels. Here also a mask is moved across the image and some arithmetical operations are carried out to detect the noisy pixels. Then filtering operation is performed only on those pixels which are found to be noisy in the previous step, keeping the non-noisy intact. The de-noising algorithm based on the threshold filter is widely used, because it's comparatively efficient and easy to realize. We can select a threshold according to the characteristic of the image, modifying all of the discrete detail coefficients so as to reduce the noise. However, we are in the dilemma of determining the level of the threshold.

Threshold can be of two types:

1. Soft threshold.
2. Hard threshold.

Soft threshold is an extension of hard threshold, first setting to zero the elements whose absolute values are lower than the threshold, and then shrinking the nonzero coefficients towards 0. Hard threshold can be described as the usual process of setting to zero the elements whose absolute values are lower than the threshold [7].

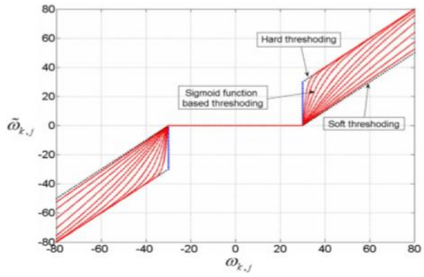

Figure 2: Decision based on threshold

The simple algorithm in which we perform the noise detection & noise removal process is given in Fig.3. We use the smallest window size which preserves the fine details of image. The window of size 3x3 chooses for noise detection and noise removal. The window contains total 9 elements. First step selects the maximum, minimum and median values of columns and rows. Second step stores these values and selects minimum threshold, maximum threshold and final median value. Third step use threshold values for noise detection and final median value for noise removal.

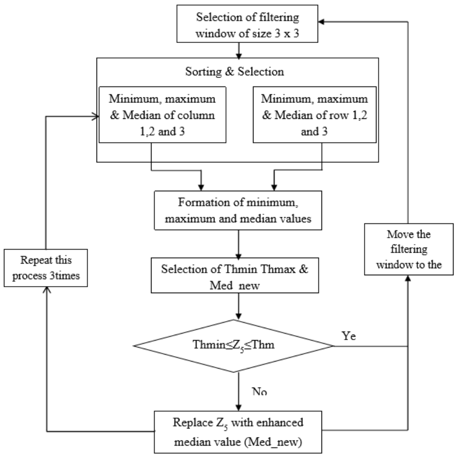

Figure: 3: Flow chart of proposed method for filtering window size 3x3

V. Conclusion

The proposed filter has proved that it is very efficient for random valued impulse noise because practically noise is not uniform over the channel. We have used the concept of maximum and minimum threshold to detect both positive and negative noise. It produces very good PSNR (Peak Signal to Noise Ratio) and very small MSE (Mean Square Error) for highly corrupted images, especially for more than 50% noise density. This algorithm is simple and requires less number of calculations than other filters like CWM, TSM, SD-ROM, IMF etc. small size of filtering window gives advantage of preservation of fine details of image. Because of its less complexity of calculation, this filter will have great application in the field of image processing. This method can be implemented using parallel processing or pipelining. With the help of parallel processing we can speed up the process and reduce execution time. Because of its easy hardware implementation, this method can replace the existing e-noising methods [8]. It can be used in GPS system as well with some modification and can give better picture quality at high noisy environment.

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