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A COMPARATIVE STUDY ON DIFFERENT TYPES OF IMAGE PREPROCESSING METHODS FOR NOISE REMOVAL

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ABSTRACT

Images are captured by the instrumental device, processed and stored in memory. During this process, the images are corrupted due to impulse noises. The images are getting corrupted due to these noises. The noise occurs due to transmission errors, malfunctioning pixel elements in the camera sensors, faulty memory locations and timing errors in analog-to-digital conversion. The aim of this survey is to provide an overview on the comparative analysis of the existing preprocessing methods and proposes a new technique for preprocessing the images that will be implemented in a Computer Aided Detection and Diagnosis System (CAD). The proposed preprocessing technique consists of two phases: the first phase consists of removing the impulse noise by calculating the impulse value and second phase consists of adding impulse value with the median value using impulse denoising filter by preserving the main image features.

Key words: Image Preprocessing, CAD, Mean Filter, Median Filter, Gaussian Filter, Laplacian Filter, Box Filter.

1. INTRODUCTION

Removal of noise is one of the fundamental problems in the field of image processing and computer era. The aim of estimating the pixel values with a given intensity is a major concern in image processing[11]. The main goal of the Preprocessing is to enhance the visual appearance of images and improve the manipulation of datasets. Preprocessing of images are those operations that are normally required prior to the analysis of datasets in images[4]. Several Filter operations which intensify or reduce certain image details enable an easier or faster evaluation [9]. The main property of a good image de-noising technique is that, which remove noise while preserving the edges. The noise occurs due to transmission errors, malfunctioning pixel elements in the camera sensors and so on.

Traditionally, linear image smoothing models have been used. For example, the Gaussian mask comprises elements determined by a Gaussian function. This convolution brings the value of each pixel into closer harmony with the values of its neighbors' using Gaussian filter[6]. One of the big advantages of linear noise removal models is the speed of removing the noisy particles in image. But the disadvantage of this model is that they are not able to preserve edges in a good manner.

Non-Linear models on the other hand can handle edges in a much better than linear models can. One example of this model is a median filter. This filter is very good at preserving the edges, but smoothly varying regions in the input image are transformed into piecewise constant regions in the output image[10].

The noisy pixel is replaced by the median/mean/mid-point value of the pixel matrix or by its neighborhood values. For high density noisy images, the replaces pixel might be again a noisy pixel which is not effective for noise removal. The non linear model replaces the noisy pixel by sorting the neighboring pixels into order based upon their intensities and replaces the original value of the pixel with the median value from the list.

- **VARIOUS SOURCES OF NOISE IN IMAGE**

Noise is introduced in the image at the time of image acquisition or transmission. The noise can affect the image to different extent based on the type of disturbance. Several parameters are responsible for the introduction of noise in the image, due to which the number of pixels corrupted. The various sources of noise in the digital image are: a) the imaging sensor may be effected by environmental conditions during image acquisition. b) insufficient light levels and sensor temperature may introduce the noise in the image. c) interference in the transmission channel may also corrupt the image. d) if dust particles are present on the scanner screen, they can also introduce noise in the image[8]. The common noise which contains the image is impulse noise. The impulse noise is the salt and pepper noise (image having the random black and white dots)[2]. Impulse noises are classified into two major types:

1. Salt and Pepper noise (equal height impulses) impulse values are represented as 0 and 255. Typical noise sources include flecks of dust inside the camera and overheated, dust particles or faulty CCD elements [7]. This noise arises in the image due to sharp and sudden changes of image signals. Image is corrupted to a small extent due to noise[10].

2. Random-valued impulse noise (unequal height impulses) impulse values are between 0 and 255. It is capable of handling low density as well as high density of random valued and fixed valued impulse noise. The noise pixel is

replaced by median value or mean value depending on the noiseless pixels. The noise is independent of intensity of pixel value at each point. Each pixel value and a random, with distributed noise value. This noise is not sufficient to provide detective statistical information.

- **OVERVIEW OF DIFFERENT DENOISING TECHNIQUES**

Image de-noising is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement [14]. An image can be filtered either in the frequency or in the spatial domain. De-noising methods can be linear as well as non-linear. Linear methods are fast enough with speed, but they do not preserve the edges, whereas the non-linear methods preserve the details of the images[15].

De-noising filters can be broadly categorized in the following categories:

i) Linear Image Smoothing Filters.
- ♣ Mean Filter
- ♣ Box Filter
- ♣ Gaussian Filter
- ♣ Laplacian Filter

ii) Non Linear Image Filters.
- ♣ Median Filter
- ♣ Spatial Filter

Mean Filter:-It is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images. It acts as a low pass frequency filter and, therefore, reduces the spatial intensity derivatives present in the image. Here the filter computes the average value of the corrupted image in a predecided area[11]. Then the center pixel intensity value is replaced by that average value. This process is repeated for all pixel values in the image.

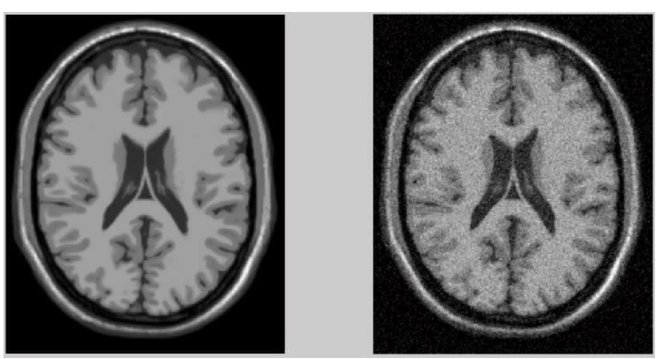

Fig.1 Mean filter used on faulty noise

Moving average or Box Filter:-This is the simplest of all **filters.** It replaces each pixel by the average of pixel values in a square centred at that pixel[4]. All **linear filters work in** the same way except that, instead of forming a simple average, a weighted average is formed. Although the **moving average filter is simple and fast, it has two** drawbacks:

1. It is not isotropic (i.e. circularly symmetric), but smoothes further along diagonals than along rows and columns.
2. Weights have an abrupt cut-o□ rather than decaying gradually to zero, which leaves discontinuities in the smoothed image.

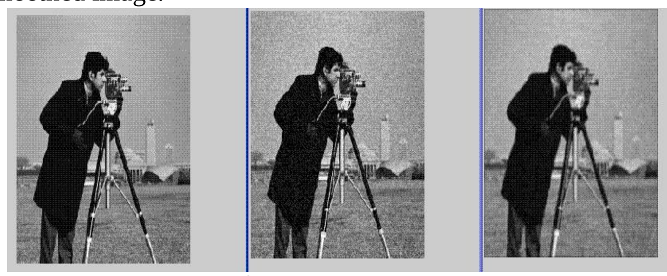

Fig.2 Average filter used on Gaussian noise

Gaussian Filter:-**These filters** are the only ones which are separable and, at least to a lattice approximation, circularly symmetric. They also overcome the other stated drawback of **moving average filters because weights decay to zero.**

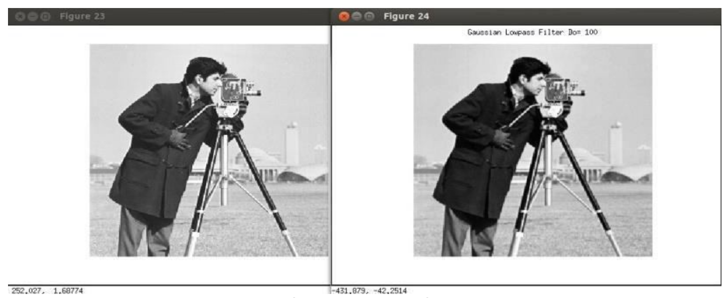

Fig.1 Gaussian filter used on faulty noise

Laplacian Filter:-Laplacian filters are derivative *filters* used to find areas of rapid change (edges) in *images*. Since derivative *filters* are very sensitive to noise, it is common *to smooth the* image (e.g., using a Gaussian filter*)* before applying the Laplacian[13].

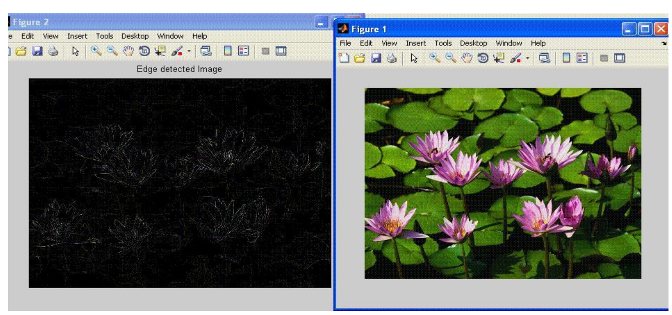

Fig.3 Laplacian filter used on impulse noise

Non Linear Filters:-**In filtering to reduce noise levels, linear smoothing filters inevitably blur edges, because both edges** and noise are high-frequency components of images. **Nonlinear filters are able** to simultaneously reduce noise and preserve edges. Nonlinear filters locate and remove data that is recognised as noise[3]. The algorithm is 'nonlinear' because it looks at each data point and decides if that data is noise or valid signal. If the point is noise, it is simply removed and replaced by an estimate based on surrounding data points, and parts of the data that are not considered noise are not modified at all. Linear filters, such as those used in band pass, high pass, and low pass, lack such a decision capability and therefore modify all data. Nonlinear filters are sometimes used also for removing very short wavelength, but high amplitude features from data. Such a filter can be thought of as a noise spike-rejection filter, but it can also be effective for removing short wavelength geological features. Image restoration is the operation of taking a corrupted/noisy image and estimating the clean original image. Corruption may come in many forms such as motion blurs noise.

Median Filter:-It is a non-linear filtering technique that is well known for the ability to remove impulsive-type noise, while preserving sharp edges. The median filter is an order statistics filter. Also Mean filter is used to remove the impulse noise. Mean filter replaces the mean of the pixels values but it does not preserve image details. Some details are removes with the mean filter. But in the median filter, we do not replace the pixel value with the mean of neighbouring pixel values, we replaces with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value[15]. The median filter gives best result when the impulse noise percentage is less than 0.1%. When the quantity of impulse noise is increased the median filter not gives best result. Since edges are minimally degraded, median filters can be applied repeatedly, if necessary[3]. The median filter tends to preserve brightness differences across signal steps, resulting in minimal blurring of regional boundaries.

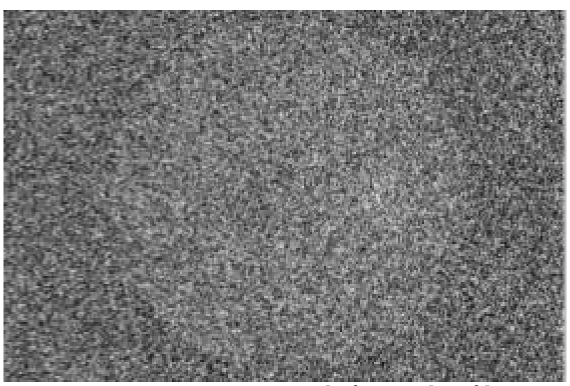

Fig.4 Noisy image before median filter

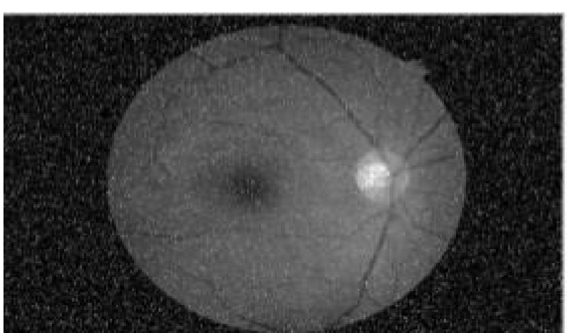

Fig.5 Image after applying Median Filter

Spatial Filter: - Spatial domain operation or filtering (the processed value for the current pixel processed value for the current pixel depends on both itself and surrounding pixels). Hence Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel[14]. A pixel's neighborhood is some set of pixels, defined by their locations relative to that pixel.

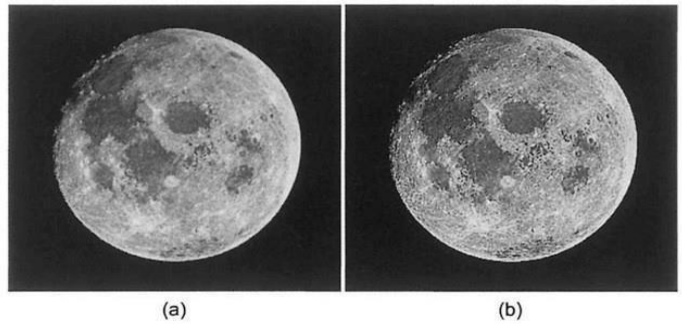

Fig.6 Spatial filter used on salt and pepper noise

2. PROPOSED HYBRID MEDIAN FILTER

This is another type of the nonlinear filter and advanced version of the median filter. The impulse noise removing is greatly improved by hybrid median filter. Here the median value of X, + shaped neighbours can be calculated and median value of that these are added to original median value.

Hybrid median filter is windowed filter of nonlinear class that easily removes impulse noise while preserving edges. In comparison with basic version of the median filter hybrid one has better corner preserving characteristics. The basic idea behind filter is for any elements of the signal (image) apply median technique several times varying window shape and then take the median of the got median values. The hybrid median filter takes two medians: in an **"**X**"** and in a **"**+**"** centered on the pixel. The output is the median of these two medians and the original pixel value.

Hybrid median filter preserves edges better than a square kernel (neighbour pixels) median filter because it is a three-step ranking operation: data from different spatial directions are ranked separately. Three median values are calculated: MR is the median of horizontal and vertical R pixels, and MD is the median of diagonal D pixels. The filtered value is the median of the two median values and the central pixel C: median ([MR, MD, C]).

$$Y = \text{median}\ \{MR, MD, C\}$$

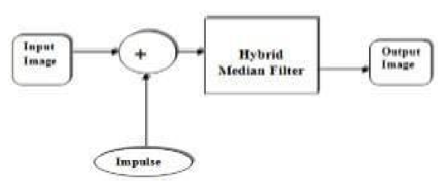

Fig.7 Hybrid median filter

Hybrid median filter algorithm

- Place a cross-window over element;

- Pick up elements;
- Order elements;
- Take the middle element;
- Place a +-window over element;
- Pick up elements;
- Order elements;
- Take the middle element;
- Pick up result in point 4, 8 and element itself;
- Order elements;
- Take the middle element.

Example of Hybrid Median Filter shows that Let's take 3*3 pixel , Account takes 5 out of the 9 total pixels including the targeted pixel which forms an 'X' on the sliding window as depicted

$$\begin{pmatrix} A & B & C \\ D & E & F \\ G & H & I \end{pmatrix}$$

$$h_1 = median(A, E, I)$$
$$h_2 = median(C, E, G)$$
$$h_3 = E$$

New Pixel Value= Median (h1,h2,h3) .

Filters re-evaluate the value of every pixel in an image. For a particular pixel, the new value is based of pixel values in a local neighbourhood, a window centred on that pixel, in order to reduce noise by smoothing, and/or – enhance edges. They provide an aid to visual interpretation of images, and can also be used as a precursor to further digital processing, such as segmentation. They may either be applied directly to recorded images, or after transformation of pixel values. These filters can smooth without blurring edges and can detect edges at all orientations simultaneously, but have less secure theoretical foundations and can be slow to compute.

3. RESULTS AND DISCUSSION

In this section, we present experimental results supporting our methodology. The experiments are performed using MATLAB (Version 7.0.4), in a system with Intel(R) core, with eight cores (3.10 GHz) and 8 GB RAM. In this proposed work, the images used as test cases include 30 images cases. The experimental result shows that Hybrid median filter is better than the existing filters in removal of noise. With images from the database, we achieved 96.76% of pre processing the image for noise removal. It insists us to include hybrid median filter which performed well in noise removal. Whereas averaging, mean and Gaussian filters performed worst. Median filter is the average choice of removing the salt and pepper noise.

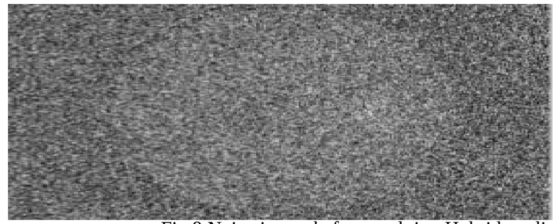

Fig.8 Noisy image before applying Hybrid median filter.

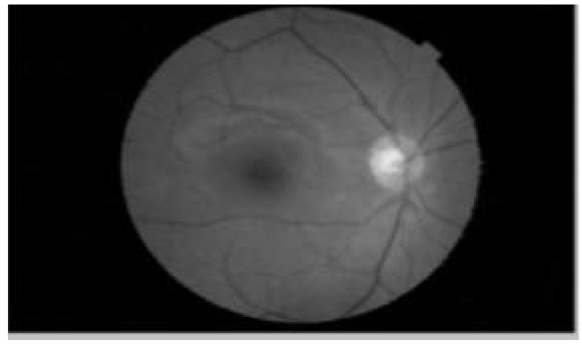

Fig.9 Image after Hybrid Median Filter

4. CONCLUSION

Hybrid filter efficiently removes impulse noise from digital images while preserving thin lines and edges in the original image. Hybrid median filter preserves edges better than a median filter. Preserves brightness difference and very simple to understand. The hybrid median filter can reduce noisy pixels more efficiently than the median filter. Main disadvantage is that it is only helpful to remove only impulse noise and High computation cost. A potential direction for our future work is to concentrate on the next phase of a CAD system based on results of the pre-processing method proposed in this paper.

REFERENCES

[1] Harish 1 and M.R.Gowtham2, "The Component Median Filter for Noise Removal in Digital Images" , International Journal of Engineering Trends and Technology (IJETT) - Volume4Issue5- May 2016.

[2] 1Bhausaheb Shinde, 2Dnyandeo Mhaske, 3A.R. Dani, "

Study of Noise Detection and Noise Removal Techniques in Medical Images", I.J. Image, Graphics and Signal Processing, 2012, 2, 51-60 Published Online March 2012 in MECS.

[3] Trapti Soni, Narendra Rathor, " Removal of High Density Impulse Noise using Efficient Median Filter for Digital Image", International Journal of Computer Applications (0975 – 8887) Volume 115 – No. 5, April 2015.

[4] Pawan Kumar Patidar, Lalit, Baldev Singh, Gaurav Bagaria, " Image Filtering using Linear and Non Linear Filter for Gaussian Noise", International Journal of Computer Applications (0975 – 8887) Volume 93 – No.8, May 2014

[5] Monika Kohli*, Harmeet Kaur**, " Noise Removal in Image Processing using Median, Adaptive Median and Proposed Median Filter and Respective Image Quality Comparison.", www.ijetmas.com November 2015, International Journal of Engineering Technology, Management and Applied Sciences, Volume 3, Special Issue, ISSN 2349-4476.

[6] Sukhjinder Kaur, "Noise Types and Various Removal Techniques", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 4, Issue 2, February 2015.

[7] H S Shukla, Narendra Kumar, R P Tripathi, " Gaussian Noise Filtering Techniques using New Median Filter" , International Journal of Computer Applications (0975 – 8887) Volume 95– No. 12, June 2014.

[8] Rakesh M.R1, Ajeya B2, Mohan A.R3, Median Filter for Impulse Noise Removal of an Image in Image Restoration , International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified organization) Vol. 2, Issue 10, October 2014.

[9] Pallav Parmar, Yashpal Yadav, Aakansha Wasnik, "Discussion of Different types of Noise Removal by Median Filter", International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified rganization) Website: www.ijircce.com, Vol. 5, Issue 7, July 2017.

[10] Isma Irum, Muhammad Sharif*, Mudassar Raza and Sajjad Mohsin, "A Nonlinear Hybrid Filter for Salt & Pepper Noise Removal from Color Images", Journal of Applied Research and Technology.

[11] James Church, Dr. Yixin Chen, and Dr. Stephen Rice, "A Spatial Median Filter for Noise Removal in Digital Images",

[12] J.Soruba Marcel1, A.Jayachandran2, G.Kharmega Sundararaj3, " An Efficient Algorithm For Removal Of Impulse Noise Using Adaptive Fuzzy Switching Weighted Median Filter" , International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 2, Issue 2.

[13] Youlian Zhu, Cheng Huang, "An Improved Median Filtering Algorithm for Image Noise Reduction *", 2012 International Conference on Solid State Devices and Materials Science. https://doi.org/10.1016/j.phpro.2012.03.133

[14] **Jayanta Das_, Bhaswati Das†, Jesmine Saikia‡ and** S.R.Nirmala§, "Removal of Salt and Pepper Noise Using Selective Adaptive Median Filter", 978-1-5090-4291-3/16/$31.00 c 2016 IEEE .

[15] Raymond H. Chan, Chung-Wa Ho, and Mila Nikolova, Salt-and-Pepper Noise Removal by Median-TypeNoise Detectors and Detail-Preserving Regularization IEEE TRANSACTIONS ON IMAGE PROCESSING.