



Trilateral Filter, Fuzzy Filter and Adaptive Morphological Median Filtering for Various Noise Removals

Er. Lovepreet Kaur, Er. Priya Kapoor

Research Scholar, Dept. of C.S.E., I K Gujral Punjab Technical University, Jalandhar, India

Assistant Professor, Dept. of C.S.E., I K Gujral Punjab Technical University, Jalandhar, India

ABSTRACT: In digital image processing, both examinations of noise variations, as well as filter design are very important. This research work has focused on a data mining method for noise type examination, and proposes an improved fuzzy filter layout for enhancing the quality of noise hazardous images. The overall objective of this paper is to improve data mining based fuzzy filter further by utilizing trilateral filter for mixed noise and adaptive morphological median filter for salt and pepper noise for efficiently removing the noise. Medical imaging is the process of art of creating visual representations of the interior of a body for clinical analysis and medical intervention. It seeks to depict internal structures that are not seen by the skin and bones and also to diagnose and then to treat disease.

KEYWORDS: Data mining & their techniques; Noise model; Fuzzy filter; Trilateral filter; Adaptive morphological median filter; Mean-median filter.

I. INTRODUCTION

An image is a collection of pixels. More precisely it can be defined as two dimensional function $f(x, y)$, here x and y are spatial coordinates, and the amplitude of f at any pair of coordinated (x, y) is called the intensity or gray level of image at that point. When x, y and the intensity values of f are finite, discrete quantities, it is known as a digital image. Digital image processing has proven fruitful in medical line to great extent. It helps in detecting brain tumor, cancer, ultra sonography and many more. As we know remote sensing is one of the application of digital image processing it help to analyze various changes which are taking place about our ecosystem like river diverting path in any area, any area is getting polluted due to some natural calamities or due to some manmade activities or if we are planning to accomplish any new city around any area we can dissect its environment by taking its pictures remotely. We can auspicate weather with help of remote sensing that what is formation of clouds and what is direction of winds. Ozone hole was also analyzed by remote sensing i.e. it helps in atmospheric study to great extend. Astronomy is one of the fabulous application of digital image processing in which we can study the formation of stars, galaxy etc. to a very great depth.

II. DATA MINING

Data mining is only an effective new innovation with awesome potential to just help organizations focus on indisputably the most pivotal data in the information they have gathered concerning the conduct of the clients and potential clients. It finds data inside of the information that questions and reports can't successfully uncover. For the most data mining is the method of breaking down information from alternate points of view and outlining it into helpful data - data that may be utilized to enhance income, cuts costs, or both. Data mining programming is clearly one of a few systematic devices for breaking down information.



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Types of data mining

A. Association Rules

Association and correlation both are used to find selected items from a data set. It tends to give better known and most ordinary results. Main thing is that it gives more straight forward information procedures or called data mining methods. You can make easily basic correlation in between two or more than two things. The transportation link between two things continuously, definitely sort some kinds of items or designs.

B. Classification

Classification is one of the most popular data mining techniques. It is depend on the aim of doing work and examine the results around particular goal. For example a tree, one root having several leaves, and all the leaves works together for a single root. This type of technique activates the arrangement to build a structure that can classify the results at highest level. There are several types of implementations are available, those are well affective on that type of investigation or analysis..

C. Clustering

Clustering is to identifying the same type of classes of objects. The set of objects e called a class and the identification of a class is called clustering. Integration of objects in class is good way to express the objects. The main reason to use that type of method for data mining is to examine the compact data in objects presented in particular class. Not only for compact data but it used for widely expressed data those are related with objects. Clustering is distinguishing widely the domain of an object as well as at compact level so that it will discover the overall arrangements and similarity in between the attributes of an object.

D. Predications

Predications are most popular technique in data mining to confirming the data sets. To confirming the selected data sets are declared by predication rules. Predication and regression are two consequently methods to authenticate the data sets. Predication rules sets the data and regression test the data set, if data set is not suitable match for the accepting pattern then it will return the data set to the previous stage for verification and then it will approve after confirming acceptable data set pattern.

III. NOISE MODELS

A. Impulse Noise

Impulse noise is an exceptional noise which can have many different origins. Some filtering techniques cannot remove the impulse noise. Linear filtering is failed to removing impulse noise; over a wide area we use non-linear filtering techniques to removing impulse noise. Impulse noise is a gray scale image that is hazy or not clear see.

B. Salt and pepper noise

The noise arise due to defected saved situations is known as impulse noise or spike noise. The noise can appear due to improper functioning of present pixel components in the camera sensors, something that is incorrect while digitizing the image. Standard values are 255 for salt noise & 0 for pepper noise for digital image.

C. Gaussian noise

In this kind of noise the regular distribution of faulty pixels has Probability Density Function also called Gaussian act of distribution. It is the major part of the image sensor which are use to read noise that is present in dark area of the image at constant level.

D. Mixed Noise Models

A number of different types connected with mixed noise designs commonly considered within the literature, such seeing that, blur and Gaussian noises ; Poisson additionally Gaussian noise as well as Gaussian plus impulse noise. As



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noise is usually regarded as stochastic along with uncertain error, probability density function (PDF) may be used to explain noise.

IV. FILTERING IN DIGITAL IMAGE PROCESSING

In digital image processing, firstly described the term filtering. Filtering in image processing is an important technique to make the image perfect. We use many types of filtering methods which described below in this paper. The main idea to using filtering in image processing is to modify the pixels of image. To convert the intensity of pixel for improve the contrast of image i.e. enhancement and to exhibit the other characteristics like smoothing i.e. remove noises and to detect known patterns also called template matching. There are several techniques to exhibit these characteristics of an original image.

A. Applications of filtering

There are several applications of filtering those are helpful in image reconstruction and enhancement procedures. Few of them are given below:

- i. *Noise Smoothing* : Linear filters are good for smoothing most types of noise; however this is at the expense of edge sharpness and fine detail. These limitations can be overcome by using trimmed filters. The MEDIAN filter is good for smoothing noise while preserving edges.
- ii. *Edge Enhancements* : Edge enhancement is often achieved by steepening the edge slope. When linear filters are used for this, it results on edges which are already sharp. Non linear filters work more reasonably well in preserving edges with the help of various order statistics filter.
- iii. *Edge Detection* : Linear edge detection filters can be made to detect edges in one particular direction or in all directions at once. Many nonlinear filters have been designed to improve edge direction in the presence of noise.

B. Types of filters

i. *Trilateral Filter* : It is one of the very effective filtering techniques. It is the improved version of bilateral filter. It has two noise detector ROAD and ROLD for discovery of noise present in damaged pixels. Joining the bilateral filter it will give the superior outcomes by performing task together. While discovering low impulse noise the ROAD trilateral filter perform task and after detecting low impulses it will eliminate them. On the other hand, preserving the high level noisy pixel discovery the ROLD trilateral filter will work and remove the raw valued impulses. In these type of noise applicants are reconstructed by using trilateral filter. The logarithmic approach defines that how much far and near the neighbor pixel from the reconstructed pixel.

ii. *Fuzzy Filter* : Fuzzy Filter, which may be seen as an extension of traditional coherent frameworks, gives a profoundly powerful calculated system for working with the issue of information representation in a situation of vulnerability and imprecision. The Fuzzy set makes for its individuals to acquire degrees of consistent enrollment. In the event that the estimation of 1 is appointed to protests completely from the set and a 0 is apportioned to questions outside of the set, then any item incompletely inside of the set will utilize a worth between 0 notwithstanding 1. The number allotted to the article is called its measure of enrollment in this set.

iii. Adaptive median morphological filter

In this technique, two new operators are introduced named as new opening operator and second is new closing operator. Short forms are known as NOP & NCP. This type of filter assembles the values of pixels in image. On the basis of NOP & NCP, it will work to remove the noisy pixels. By using an algorithmic approach it will protect the image details and other small facts of an image. The adaptive median morphological filter recommended keeping away from harming of excellent pixels available in image. These types of filtering technique activate the switching scheme on the bases of numerical fact those accomplished the impulses. The discovery of impulses through various typical variation distinctions of pixels inside the filter kernel and in the interest of recent pixel.

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V. RELATED WORK

Dend,Z-F et al.[1] has depicted an filter which is based on mathematical morphology for high probability impulses removal is presented. Firstly, an impulse noise detector using mathematical residues is presented to recognize pixels that are polluted by salt and pepper noise. Then the image is reconstructed using specialized open-close sequence algorithms that apply only to the damaged pixels, finally, black and white chunks that reduced the quality of the image will probably be recovered by a block sensible erase approach. Experimental effect exhibit that the recommend filter outperforms a number of existing algorithms and is efficient for the very extremely spoiled images.

Harish Kundra et al. [2] made a discussion about the Image Enhancement Based On Fuzzy Logic. Here a filter is introduced that'll take away the noise and enhance the contrast of the image. To make this happen, the goal of fuzzy-logic-control based approach is used. The filter is tested on the coloured images. The contrast can also be improved. Visual quality is not satisfactory.

K.K.V et at.[3] has presented a novel two stage noise versatile fuzzy switching mean filters also called NAFSM filtration. It is use for salt and pepper noise discovery and removal. Initially, the recognition of execution level will make use of histogram from damaged image to recognize noisy pixels elements. These types of discovered?? Noisy pixels?? Will then be subjected to the subsequent stage from the filtering motion, during ?? Noise free pixels?? are usually retained and left natural.

Leung et al. [4] proposed an algorithm that allowed users to state their interest when it comes to constraints and uses the Map Reduce model to mine uncertain Big data for frequent patterns that satisfy the user-specified constraints. By exploiting properties of the constraints, their algorithm greatly reduces the search space for Big data mining of uncertain data, and returns only those patterns which are interesting to the users for Big data analytics.

M.H. Sedaaghi et al.[5] has depicted a new morphological filter using weighted morphological operators in current time. The recently discover operators put to use a weighted structuring element and apply multiplication or division. But the traditional morphological operations use addition and subtraction. The new operator's working controls those traditional operators for signal buried in Gaussian noise and salt & pepper noise.

Xuechen Li et al.[6] has displayed few practically algorithm in the manner to discover impulses located at the inner side the picture of your heated joint completely, the enhance replacing median filtering or (ISM) is recommended. In the inner side of the algorithm, the small courses to find noise or noise detector can be acquiring to sorting the pixels in the inner side of the picture into not damaged pixel and also damaged pixels with the presence of noise. The main thing is that without the presence of noise in pixels are leaving not developed.

Zhou Wang et al.[7] has analyzed a latest median filtering, Those images are spoiled by salt and pepper impulses. The technique is build by using two important techniques. First technique is, switching technique is an impulse discovery algorithm. In which the impulses are finding out before filtering, so that a ratio of all the founded pixels will be filtered.

VI. PROPOSED ALGORITHM

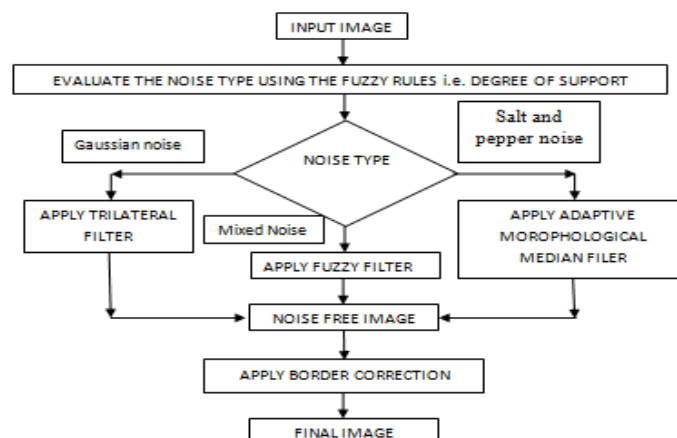


Fig 1.2: Flow chart of proposed system

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The steps in proposed system:

- i. Select an image whether the image is colored or gray image.
- ii. After selecting the image, Evaluate the type of noise with the help of fuzzy rules.the fuzzy rules works on the basis of degree of support.
- iii. According to noise type the suitable filter will apply.
- iv. If Gaussian noise found, apply the trilateral filter.
- v. If the mixed noise found, apply fuzzy filtering rules.
- vi. If salt & pepper noise is found, apply adaptive morphological median filter.
- vii. After that the image is noise free, then apply some border correction so that we get noise free final image.

VII. SIMULATION RESULTS

The simulation results are given below. We select input image 1 and after applying algorithm it will find the noise type present in image. What type of noise is present in input image and what type of filter will be applied related to noise detection and removal technique, the system will work. There are main three types of filter. First is fuzzy filter, it will apply on the image when the mixed noise has found in the image. Second filter is trilateral filter. It will apply on image when the noise type is Gaussian. Last and third filter will apply when the salt & pepper noise has found in the image. Actually in this, the work will do on the multiplicative noise. There are several types of noises are available and according to noise the suitable filter will apply on the image to removing the noise from image.

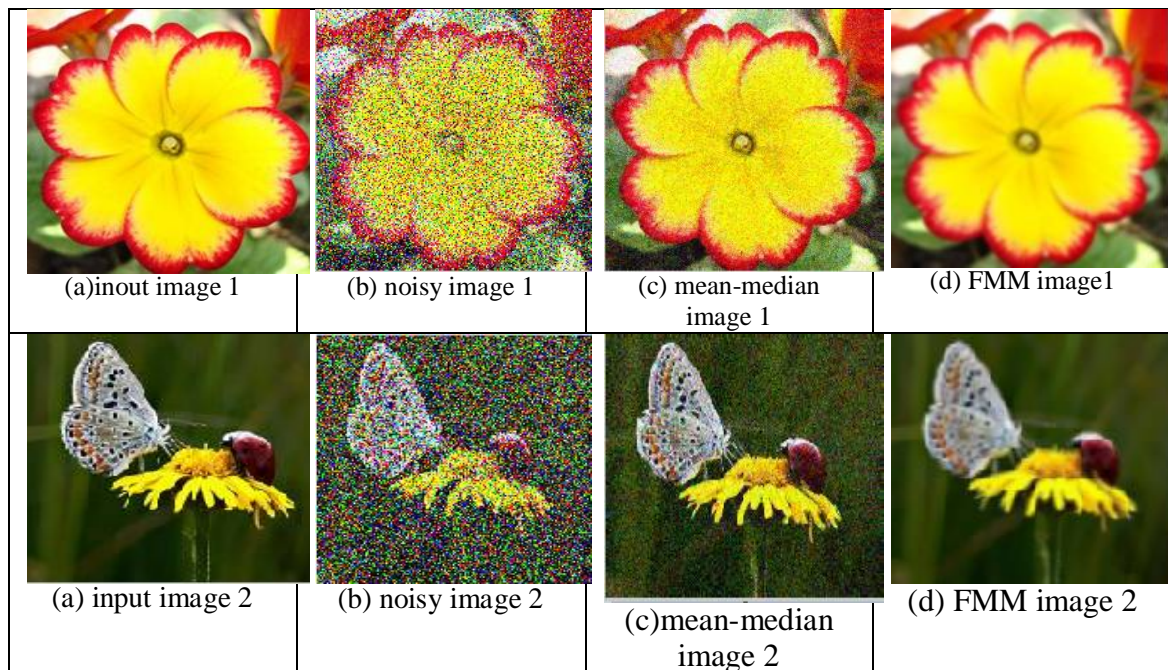


Fig 1.3: Flow chart of proposed system

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VIII. PERFORMANCE EVALUATION

A. *MSE (mean square error)* : Mean square error is to compute an error signal by subtracting the test signal from the reference, and then computing the average energy of the error signal. It can be explained as:

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (f(i,j) - f'(i,j))^2$$

Table 1: MSE comparison Table

INPUT	EXISTING	PROPOSED
IMAGE 1	407	56
IMAGE 2	534	246
IMAGE 3	479	102
IMAGE 4	566	183
IMAGE 5	470	39
IMAGE 6	500	40
IMAGE 7	496	119
IMAGE 8	571	158
IMAGE 9	527	49
IMAGE 10	431	45

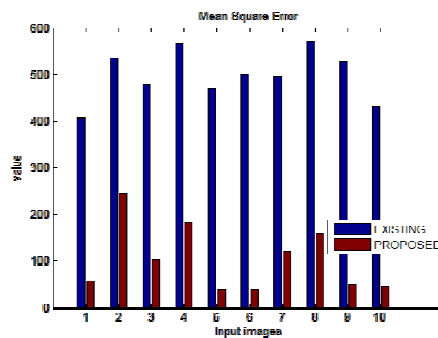


Fig 1.4: MSE Graph

B. *PSNR (peak signal to noise ratio)* : Peak square noise ratio is the ratio between the Maximum possible value of the signal and the power of the corrupting noise. It is measured in decibels (db). It can be explained as: PSNR =

$$10 \cdot \log_{10} \left(\frac{\text{MAX}_I^2}{\text{MSE}} \right)$$

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Table 1.2 PSNR comparison Table

INPUT	EXISTING	PROPOSED
IMAGE 1	22.0349	30.6489
IMAGE 2	20.8554	24.2215
IMAGE 3	21.3274	28.0448
IMAGE 4	20.6026	25.5063
IMAGE 5	21.4098	32.2209
IMAGE 6	21.1411	32.1102
IMAGE 7	21.1760	27.3753
IMAGE 8	20.5644	26.1442
IMAGE 9	20.9127	31.2288
IMAGE 10	21.7860	31.5987

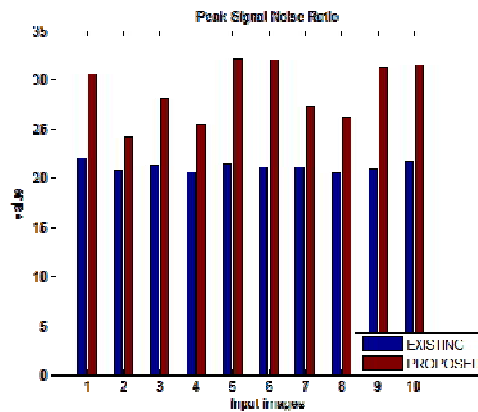


Fig. 1.5: PSNR Graph

C. *RMSE values* : Root-mean-square error is a measure of the differences between values predicted by a model or an estimator and the values actually observed. It can be explained as: $RMSE = \sqrt{MSE}$

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Table 1.3 Root Mean Square Error

INPUT	EXISTING	PROPOSED
IMAGE1	20.1742	7.4853
IMAGE2	23.1084	15.6844
IMAGE3	21.8861	10.0995
IMAGE4	23.7908	13.5277
IMAGE5	21.6795	6.2450
IMAGE6	22.3607	6.3246
IMAGE7	22.2711	10.9087
IMAGE8	23.8956	12.5698
IMAGE9	22.9565	7
IMAGE10	20.7605	6.7082

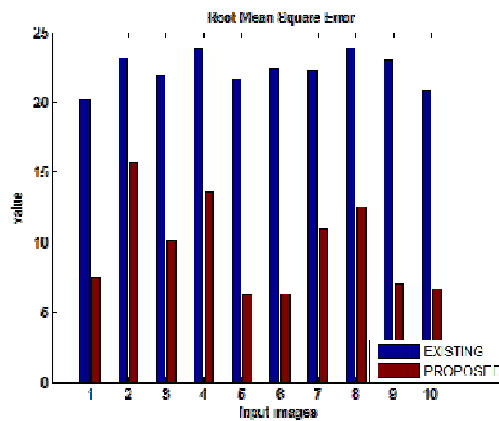


Fig: 1.6: RMSE comparison

IX. CONCLUSION AND FUTURE WORK

In this paper, we have evaluated the performance of data mining based image filtering technique for the detection of noise (i.e Gaussian noise, Mixed noise & impulse noise). To utilize trilateral filter for Gaussian noise, Fuzzy filter for mixed noise and adaptive morphological median filtering for salt & pepper noise eliminates the noise using data mining within an efficient manner. The comparison of the proposed filters with the existing filters is also done by using low density of Gaussian, Impulse noises in relation to the various parameters: PSNR, MSE, RMSE. The proposed work results are much better than the existing results.



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