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# THE COMPARATIVE ANALYSIS OF FUZZY FILTERING TECHNIQUES

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**Abstract—** In digital image processing, detecting and removing the noise from images in efficient manner is always an open part of research. But has been learned that the all the present research has neglected the utilization of data mining technique which can be used to detect noise present in images and the effective use of traditional filters helps to remove noise inside images. The experimental results computed on MATLAB software with Image Processing toolbox. The comparison of existing filters such as FMM is done with the proposed filters such as FBD filter in order to remove low density of noise. The performance evaluation of the gray scale images with Peak signal to noise ratio, Mean square error and Root mean square error shows the promising results of proposed filters.

**Keywords—**Data mining, bilateral filter, decision based alpha trimmed median filter, FMM, FBD

## I. INTRODUCTION

The data mining technique is employed to check what sort of disturbances is available in the image. There are diverse varieties of disturbances that could be available in the actual image, for instance, Gaussian noise, salt and pepper noise, speckle noise, Poisson noise and so on [1]. These disturbances is generally shaped by the genuine sensors, hardware of scanner or each time a discernment obtained because of the real camera. Before any subsequence managing simply like edge identification or maybe protest acknowledgment, it is very essential to expel unsettling impact from unique image.

Data mining could be the act of speedily looking outlets of information to obtain examples and patterns that surpass essential investigation. Data mining makes usage of modern scientific computations to portion the data and assess the particular likelihood of upcoming occasions. Data mining may well answer many inquiries which have been not tended to help through straightforward question and credit scoring methods [2]. Data mining, a vital section of learning revelation, is said within the grounds that the actual computerized disclosure in relation to beforehand obscure, nontrivial, alongside conceivably helpful sights from various databases. These data mining techniques are accomplished simply because they build models. A model employs an algorithm to do something on a few data. The notion of automatic discovery could be the term for the execution of data mining techniques. Data mining models allows mining the data where they may be constructed, but most kinds of models are normal to new data. The process of applying a form to new data is known as scoring. Other forms including data mining identify natural groupings inside the data [3]. The data mining technique used in this paper is fuzzy logic or fuzzy reasoning.

## II. FUZZY LOGIC

Fuzzy logic is usually conceptualized as a new generalization of established logic. Modern fuzzy logic was created to model those problems where imprecise data can be used or in that this rules of inference are formulated in a really general way employing diffuse categories [4]. Inside fuzzy logic, that is also sometimes referred to as diffuse logic, here there are not just two alternatives

but an entire continuum of simple fact values for reasonable propositions. The common route is always to generalize the studies of multi-valued logic in a way as to preserve section of the algebraic structure. A fuzzy set theory corresponds to fuzzy logic plus the semantic of fuzzy operators is usually understood using any geometric model [5]. The geometric visual images of fuzzy logic will deliver a hint regarding possible connection together with neural networks. The fuzzy operators are usually conceived as generalized end result functions of processing units. An expert in a very certain field can on occasion produce a simple pair of control rules for just a dynamical system together with less effort compared to work involved inside training a nerve organs network. Fuzzy logic is actually being used in several products of industrial and electronic devices [6].

## III. FILTERS

The majority of images are affected to some extent by noise, which is unexplained variation inside data: disturbances in image intensity that happen to be either not interpretable or not of interest. Image analysis is often simplified if this noise is usually filtered out. In an analogous way filtration are used in hormones to free beverages from suspended harmful particles by passing them via a layer of mud or charcoal. Engineers working in signal processing have extended this is of the term filter to add in operations which accentuate highlights of interest in files. Filters provide a great aid to visual interpretation of photographs, and can also double as a precursor to help expand digital processing [7].

The different types of filters used in image processing are existing filters such as (FMM) fuzzy-mean-median filter, mean filter, median filter and proposed filters such as bilateral filter, decision based alpha trimmed median filter and FBD (fuzzy-bilateral-DBMF) filter . These filters can remove different type of noises present in the images.

### 3.1 FMM (Fuzzy-Mean-Median) Filter

It is an approach to mix both mean filter and median filter along with a modification parameter. This adjustment parameter is simply corresponding to the fuzzy membership function. This novel filter, fuzzy media-mean (FMM) filter, is aimed to eliminate the mixed noises such as Gaussian noise and Impulse noise. The fuzzy media-mean filter operates on a filtering window.

The mean filtering is normally considered as a convolution filter which represents the design and size of the neighborhood to be sampled when calculating the mean. This filter is used in existing algorithm to remove Gaussian noise.

The key concept of the median filter is to operate through the signal entry by entry, replacing each entry with the median of neighbouring entries. This filter is used in existing algorithm to remove Impulse (salt & pepper) noise.

### 3.2 Bilateral Filter

This filters smooth images without effecting edges, by means of a non-linear combination of nearby image values. In this filter replaces each pixel by weighted averages of its neighbour's pixel. The weight assigned to each neighbour pixel decreases with both the distance in the image plane and the distance on the intensity axis. This filter helps us to get result faster as compare to other. This filter is used in proposed algorithm to remove Gaussian noise.

### 3.3 Decision Based Alpha Trimmed Median Filter

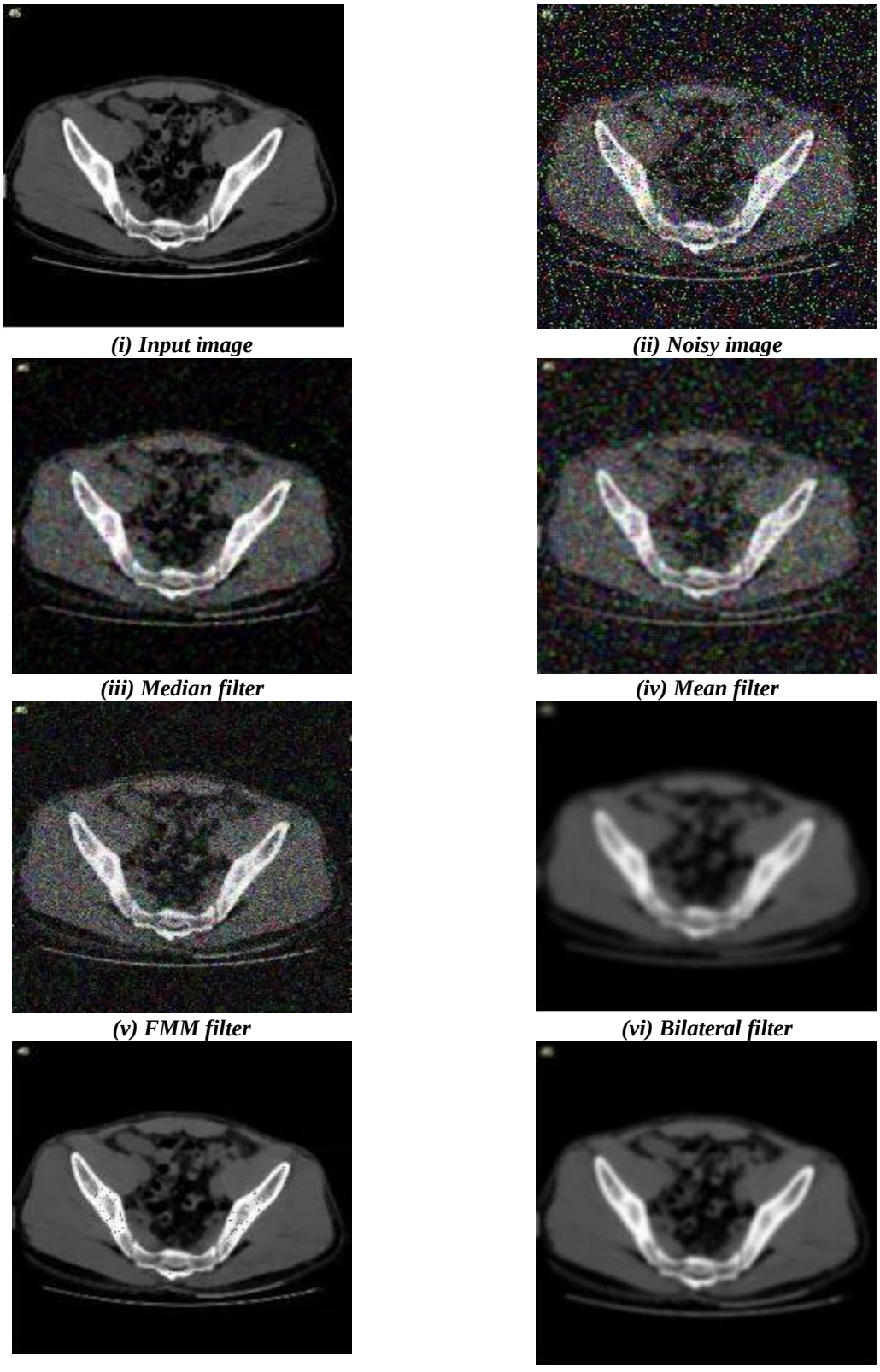
This filter is a windowed filter regarding non-linear class. The basic idea behind filter is perfect for any element with the signal (image) look at its neighborhood, discard probably the most atypical elements in addition to calculate mean value with all the rest of these. This filter is used in proposed algorithm to remove Impulse noise.

### 3.4 FBD (fuzzy-bilateral-DBMF) filter

This filter is used in proposed algorithm to remove mixed noises such as Gaussian noise as well as Impulse noise. This filter helps to increase the quality of the image at great extent.

## IV. SIMULATION RESULTS



*(i) Input image* *(ii) Noisy image*

*(iii) Median filter* *(iv) Mean filter*

*(v) FMM filter* *(vi) Bilateral filter*

*(vii) DBMF filter* *(viii) FBA filters*

***Figure 1. Experimental results of colored images***

The figure (i) represents the input gray scale image taken from any camera or any printing or scanning devices.
The figure (ii) is the noisy image in which various noises are present. Many noises such as Gaussian noise and impulse (salt & pepper) noise are present inside an image.
The figure (iii) shows the output of the median filter. This median filter is used to remove impulse noise from an image.
The figure (iv) shows the output of the mean filter. This mean filter is used to remove Gaussian noise from an image.
The figure (v) shows the output the existing works, which uses Fuzzy-Mean-Median filter (i.e. FMM filter). This FMM filter is used to remove mixed noises (Gaussian noise & impulse noise) from an image. But the quality of the image is not improved by using FMM filter.
The figure (vi) shows the output the bilateral filter. This filter is used to remove Gaussian noise from an image at the great extend than the mean filter.
The figure (vii) shows the output the decision based alpha trimmed median filter, which is used to remove impulse noise from an image as well as enhance the quality of the image. The figure (viii) shows the output of the proposed fuzzy filter (i.e. FBA) Filter that is used to remove mixed noises (Gaussian noise, impulse noise). The experimental result shows that outputs of the filters with low noise density of Gaussian noise and Impulsive noise.

## V. PERFORMNACE EVLAUTAION FOR LOW DENSITY OF NOISES

**5.1 PSNR (peak signal to noise ratio)-** Peak square noise ratio is the ratio of maximum signal to the noise present in that signal. It is measured in decibels (db) units. The comparison table and graph of the existing filters and proposed filters is shown below.

***Table 1. PSNR comparison table***

| Input Images | Low Noise densities | Mean Filter | Median Filter | FMM Filter | Bilateral Filter | DBMF Filter | FBD Filter |
|---|---|---|---|---|---|---|---|
| 1. | Gaussian=0.01 Impulse=0.05 | 22.3905 | 24.9293 | 21.0459 | 22.8506 | 27.5605 | 26.7672 |
| 2. | Gaussian=0.02 Impulse=0.10 | 18.8622 | 23.7217 | 18.5355 | 24.3349 | 29.8924 | 27.8723 |
| 3. | Gaussian=0.03 Impulse=0.15 | 18.5261 | 21.5221 | 16.6556 | 25.7731 | 33.6567 | 29.7844 |
| 4. | Gaussian=0.04 Impulse=0.20 | 16.0410 | 19.5877 | 16.0171 | 23.7151 | 27.0737 | 26.9852 |

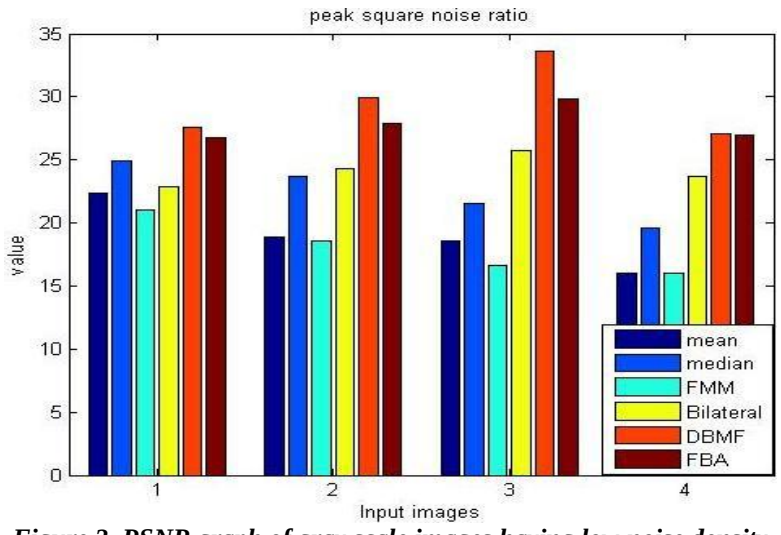



***Figure 2. PSNR graph of gray scale images having low noise density***

This gray scale image graph shows that the values of PSNR of proposed filters are as high as possible than the existing work.

**5.2. MSE (mean square error) -** Mean square error is to calculate an error signal by subtracting the test signal from the reference, and then computing the average energy of the error signal. The comparison table and graph of the existing filters and proposed filters is shown below.

***Table 1. PSNR comparison table***

| Input Images | Low Noise densities | Mean Filter | Median Filter | FMM Filter | Bilateral Filter | DBMF Filter | FBD Filter |
|---|---|---|---|---|---|---|---|
| 1. | Gaussian=0.01 Impulse=0.05 | 375 | 209 | 511.0827 | 337.2997 | 114.0337 | 136.8871 |
| 2. | Gaussian=0.02 Impulse=0.10 | 845 | 276 | 911.0148 | 239.6593 | 66.6558 | 106.1337 |
| 3. | Gaussian=0.03 Impulse=0.15 | 913 | 458 | 1404.4831 | 172.0971 | 28.0164 | 68.3347 |
| 4. | Gaussian=0.04 Impulse=0.20 | 1618 | 715 | 1626.9014 | 276.4199 | 127.5587 | 130.1858 |

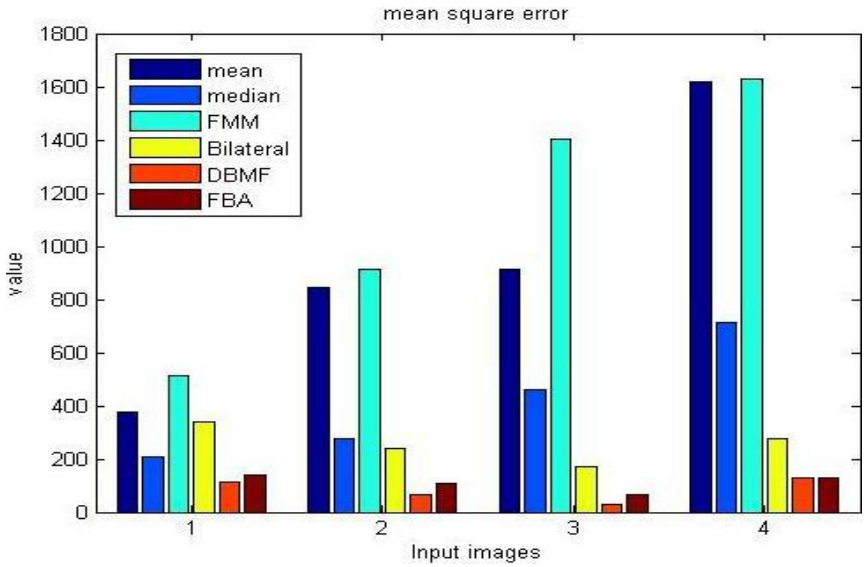



***Figure 3. MSE graph of gray scale images having low noise density***

This gray scale image graph shows that the values of MSE of proposed filters are as low as possible than the existing work.

**5.3. RMSE (Root Mean Square Error) -** Root-mean-square error is a measure of the differences between values predicted by a model or an estimator and the values actually observed. The comparison table and graph of the existing filters and proposed filters is shown below.

***Table 1. PSNR comparison table***

| Input Images | Low Noise densities | Mean Filter | Median Filter | FMM Filter | Bilateral Filter | DBMF Filter | FBD Filter |
|---|---|---|---|---|---|---|---|
| 1. | Gaussian=0.01 Impulse=0.05 | 19.3649 | 14.4568 | 22.6071 | 18.3657 | 10.6787 | 11.6999 |
| 2. | Gaussian=0.02 Impulse=0.10 | 29.0689 | 16.6132 | 30.1830 | 15.4809 | 8.1643 | 10.3021 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3. | Gaussian=0.03 Impulse=0.15 | 30.2159 | 21.4009 | 37.4764 | 13.1186 | 5.2931 | 8.2665 |
| 4. | Gaussian=0.04 Impulse=0.20 | 40.2244 | 26.7395 | 40.3349 | 16.6259 | 11.2942 | 11.4099 |

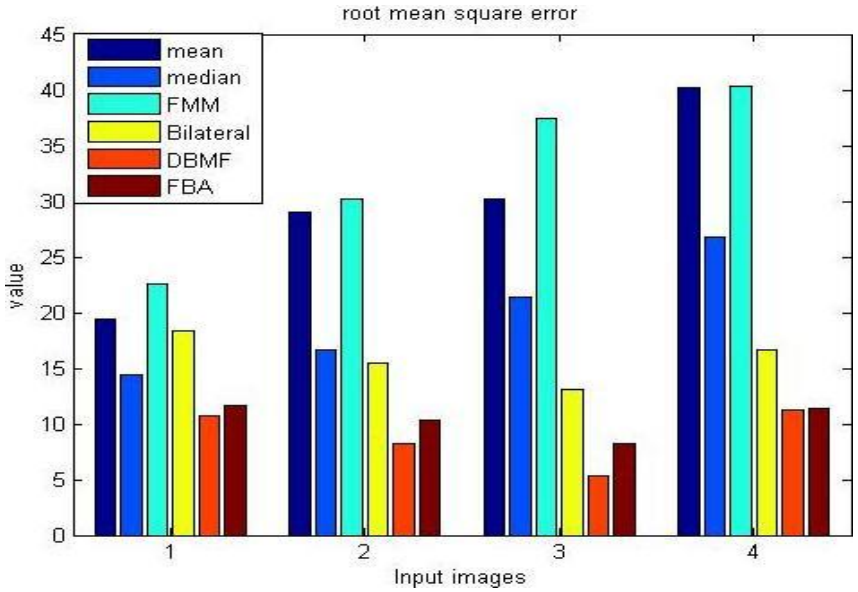



***Figure 4. RMSE graph of gray scale images having low noise density***

This gray scale image graph shows that the values of root mean square error of proposed filters are as low as possible than the existing work.

## VI. CONCLUSION

Throughout digital image processing, both identification of noise type in images together with filter design tend to be incredibly important. Conventional filtering procedures for image clean up like median filters and mean filters aren't productive oftentimes. This FBD filtering boasts demonstrated promising results above the prior techniques, since it utilizes the favorite features to remove mixed noise at great extend than the existing filter FMM. The proposed technique have been designed and carried out inside MATLAB making use of image processing toolbox. The comparison shows the outputs of the proposed algorithm which is much better than the existing algorithm.

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