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# Comparative Analysis of Image Denoising Techniques

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***Abstract- A noise gives an image a generally undesirable appearance, the most significant factor is that noise can cover and reduce the visibility of certain features with in the image. Now, a days use of image is becoming popular as it is used in various applications like medical, education, military etc. Introduction of various noises (Salt & Pepper noise, Gaussian noise, mixed noise etc.) in image can be from various factors like during transmission or any other mode. In this paper we compare about various denoising techniques to remove impulse noise from images and their features. Comparison is done on the basis of Peak Signal to Noise Ratio (PSNR) value.***
***Keywords-PSNR, Salt and Pepper Noise, Gaussian Noise, denoising, mixed noise .***

## I. INTRODUCTION

Image denoising is an important image processing task, both as a process itself, and as a component in other processes. There are many ways to remove noise from an image or a set of data exists. The main property of a good image denoising model is that it will remove noise while preserving edges. Images are often corrupted by two types of noise: Gaussian noise and impulsive noise. Gaussian noise typically occurred in image acquisition process and is modeled by adding each pixel a value from a zero-mean Gaussian distribution, thus all pixels of the image are affected. Because of its zero-mean nature, Gaussian noise can normally be removed by averaging similar pixels in a pixel's local neighborhood [4].Impulsive noise is also called as Salt and pepper noise or a fixed value impulsive noise because the intensity value of images is changed into 0 or 255 when the image is contaminated by noise. Impulse noise is caused by faulty camera sensors, faults in data acquisition systems and transmission in a noisy channel [5]. There are various methods that helps to remove noise from the image. But better performance depends on the selection of appropriate method for image denoising.

## II. TECHNIQUES FOR NOISE REMOVAL

### *A. Standard Median Filter*

The standard median (SM) filter is a simple nonlinear smoother that can suppress noise while retaining sharp sustained changes (edges) in signal values. It is particularly effective in reducing impulsive-type noise. This filter also attempts to remove impulse noise from the center pixel of a given filter window by replacing this pixel with the median of pixels with in the window. Though this method is simple and efficient in terms of noise removal capability.

### *B. Decision Based Algorithm*

Decision Based Algorithm (DBA) is also known as Switching Median Filter (SMF). In this filter is used to minimize the undesired alteration of uncorrupted pixels by the filter. Overcome this problem, switching median filter checks each input pixel whether it has been corrupted by impulse noise or not. Then it will be change only the intensity of noisy pixel candidates, while left the other pixels unchanged the decision is based on a threshold value. This filter repeated replacement of neighboring pixel produces streaking effect.

### *C. Median Filter*

The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median.

### D. *Adaptive Median Filter*

This filter smooths the data while keeping the small and sharp details. The median is just the middle value of all the values of the pixels in the neighborhood. Note that this is not the same as the average (or mean); instead, the median has half the values in the neighborhood larger and half smaller. The median is a stronger "central indicator" than the average. In particular, the median is hardly affected by a small number of discrepant values among the pixels in the neighborhood. Consequently, median filtering is very effective at removing various kinds of noise.

### E. *Modified Decision Based Unsymmetrical Trimmed Adaptive Median Filter*

In order to overcome the drawback of Unsymmetric trimmed median filter, an Unsymmetric trimmed adaptive median filter is used in this window size is selected dynamically depending on the total number of noisy pixels in the selected window. If ¾$^{th}$ or more pixels in the selected 3x3 window are noisy, then window of size 5x5 is selected. The selected 3x3 or 5x5 window elements are arranged in either increasing or decreasing order. Then the pixel values 0"s and 255"s in the window (i.e., the pixel values responsible for the salt and pepper noise) are removed from the window. Then the median value of the remaining pixels is taken. This median value is used to replace the noisy pixel. This filter is called trimmed adaptive median filter because the pixel values 0"s and 255"s are removed from the dynamically selected window.

### F. *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 gives 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 works and remove the raw valued impulses. In this 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.

### G. *Fuzzy Peer Group Filter*

A fuzzy peer group will be defined as a fuzzy set that takes a peer group as support set and where the membership degree of each peer group member will be given by its fuzzy similarity with respect to the pixel under processing. The fuzzy peer group of each image pixel will be determined by means of a novel fuzzy logic-based procedure. We use the fuzzy peer group concept to design a two-step color image filter cascading a fuzzy rule-based switching impulse noise filter by a fuzzy average filtering over the fuzzy peer group. Both steps use the same fuzzy peer group, which leads to computational savings. This filter is able to efficiently suppress both Gaussian noise and impulse noise, as well as mixed Gaussian-impulse noise.

### H. *Boundary Discriminative Noise Detection Filter(BDND)*

Boundary discriminative noise detection (BDND) is a highly used noise reduction method for strongly denoising extremely corrupted images. BDND works under different impulse noise models. It mostly uses switched Enhanced BDND Algorithm for High Density Impulse Noise removal median filter as it removes noise without any pixel misclassification .It classifies pixels of localized current window pixels into three distinct categories and this algorithm works on the affected pixels and replaces it for the noise free image

The BDND algorithm is applied to each pixel of the noisy image in order to identify whether it is uncorrupted or corrupted. The uncorrupted pixels are left unchanged. It comprises of noise detection and filtering stages for impulse noise removal.

## III. PERFORMANCE METRICS

To evaluate the performance of the de noising techniques several parameters are available. We are using Peak Signal to Noise Ratio (PSNR). Peak Signal to Noise Ratio (PSNR) estimates the superiority of the recreated image in respect to the original image. Greater the PSNR better will be the reconstructed images. Equation1 shows the mathematical function of peak signal to noise ratio.

$$PSNR(dB) = 10log_{10}\left(\frac{255^2}{\frac{1}{M\times N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(O-D)^2}\right) \qquad (1)$$

where $O$ is the original image of size $M\times N$ and $D$ is the restructured image.

## IV. PERFORMANCE ANALYSIS

Table 1. shows the PSNR (peak signal to noise ratio) for various techniques at different impulse noise densities.

Table 1.Comparison of PSNR values of different algorithms at different noise densities.

| Noise Density (%) | Standard Median Filter | Fuzzy Peer Group Filter | Decision Based Algorithm | Median Filter | Adaptive Median Filter | Trilateral Filter | Boundary Discriminative Noise Detection Filter (BDND) | Modified Decision Based Symmetrical Trimmed Adaptive Median Filter(MDBSTAM) |
|---|---|---|---|---|---|---|---|---|
| 10 | 22.37 | 25.773 | 27.16 | 28.47 | 28.43 | 31.662 | 32.1528 | 38.08 |
| 20 | 19.7 | 24.85 | 26.77 | 27.00 | 27.40 | 30.91 | 30.1956 | 34.44 |
| 30 | 18.24 | 24.45 | 26.22 | 25.48 | 26.11 | 29.98 | 29.2674 | 32.02 |
| 40 | 16.2 | 23.12 | 25.40 | 24.51 | 24.40 | 28.57 | 28.1822 | 30.39 |
| 50 | 13.66 | 22.08 | 24.58 | 23.65 | 23.36 | 26.05 | 27.034 | 28.89 |

## V. CONCLUSION

In this paper impulse noise reduction techniques were compared by using PSNR value .The experimental results show that Modified Decision Based Symmetrical Trimmed Adaptive Median Filter performed well than the other methods.

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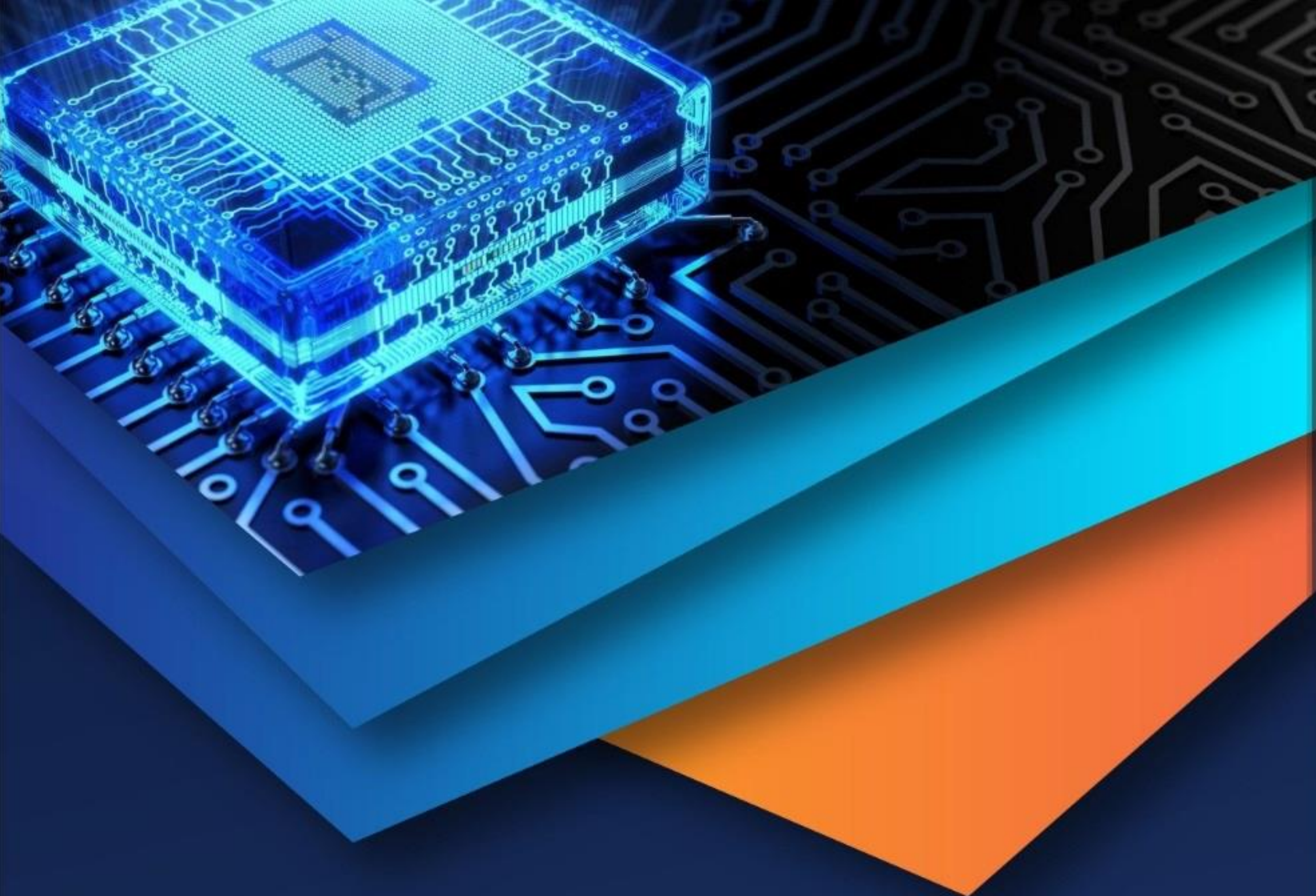


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