Enhancement of Image with the help of Switching Median Filter

M. M. Zade
Asst.Professor
SVERI's College of Engineering, Pandharpur

S. M. Mukane
Professor
SVERI's College of Engineering, Pandharpur

ABSTRACT
The filtering scheme proposed in this paper finds the impulse noise in the image with the help of switching median filter. The corrupted and uncorrupted pixels in the image are find by comparison between the pixel value with the one (max) and zero (min) values in the transparent panel (window) which we selected one. If the pixel intensity is belongs to the zero (min) and one (max) values, then it is an uncorrupted pixel and it is left as it is. If the value does not belong within the particular value, then it is a corrupted pixel and is substituted by the median pixel value or already processed immediate neighboring pixel in the current filtering window**.** A switching median filtering scheme has been developed in this paper. This filter help to eliminate the impulse noise and this filter has been producing strong impression to improve the performance. Filtering scheme is carried out on only on corrupted pixels, and uncorrupted pixels are remaining as it is. Due to this reason pixel misplaced process gets prevented. So that the proposed filter outcome images are found to be pleasant for visual perception and also the beneficial features of the images, namely, edges and fine details are preserved satisfactorily. The proposed filter has been shown to out-perform other existing filters in terms of noise elimination and feature preservation properties.

General Terms
TMF-Traditional median filter, SMF-Standard median filter

Keywords
Salt and pepper noise, impulse noise, mean square error, SMF, peak signal to noise ratio

1. INTRODUCTION
Filtering process plays an important role in any signal processing system, which gives an estimation of signal degradation and restoring the signal satisfactorily with its features preserved intact. Several filtering techniques have been reported in the literature over the years, suitable for various applications. Nonlinear filtering methods are preferred for denoising images which are degraded by impulse noise. These nonlinear filtering methods considered for nonlinear nature of the human visual system. Thus, the filters having good edge and better image information preservation properties are highly desirable for human visual perception. The median filter and its variants are among the most commonly used filters for impulse noise elimination. The median filters, when applied uniformly across the image, modify both noisy as well as noise free pixels, resulting in blurred and distorted features [1-2]. Recently, some modified forms of the median filter have been proposed to overcome these limitations. In these variants, namely, the novel switching median filters, a pixel value is altered only if it is detected to have been corrupted by impulse noise [3-5]. These variants of the median filter still retain the basic rank order structure of the filter. Salt-and-pepper noise is relatively considered for two intensity levels in the noisy pixels, that is, 255 and 0. The impulse noise is detected using decision mechanism with a pre-set threshold value [6] and the corrupted pixels alone are subjected to filtering. The window size is increased to achieve better noise removal. However, the increased window size results in less correlation between the corrupted pixel values and replaced median pixel values.

2. LITERATURE REVIEW
A lot of methods have been improved to eliminate noises. Filters are one of the most common tools which are used to eliminate noises. Many filters have been designed so far because of over plus of the noise varieties and differences between the properties of these noises. Generally, filters are divided into two groups as linear and non-linear. Linear filters have simple design and encoding and they are intended for general aim. These filters can be used to smooth the images or enhance the edges but they have weak capacity for noise elimination. Non-linear filters have been designed for specific aim and they produce better results. Non-linear filters are divided in many categories. Order statistic filter is one of the categories of non-linear filters. It is the most popular filter for noise elimination [3].One of the most important stages of signal and image processing is noise elimination. Noise is an unwanted perturbation to a wanted analog or digital signal or image [1]. A noise can be categorized depending on its source, frequency spectrum and time characteristics. Depending on a source, the noises are categorized into six types: acoustic noise; thermal and shot noise; electromagnetic noise; electrostatic noise; channel distortions, echo and fading; processing noise. On the other hand, depending on the frequency spectrum or time characteristics, the noises are also categorized into six types: white noise; band-limited white noise; narrowband noise; colored noise, impulsive noise, transient noise pulses [2].The subject of this study is to investigate and improve the noise eliminating methods related to digital images. Noise is unwanted pixels to be corrupted into digital images. The principal sources of noises in digital images arise during image acquisition (digitization) and/or transmission. The performance of imaging sensors is affected by a variety of factors such as bad focusing; motion and non-linearity of the sensors, etc. [1]. Type of noises has to be known for elimination of noises in digital image. If the noise type is unknown, the filter which will be applied to image can't be known. In such a case all filters are applied to images and each image is examined and then the filter which will produce the best result can be determined. The first problem occurs if it is unknown that there is noise in images or if the type of noises is unknown. This problem has not been solved

yet. The second problem is the lack of values that will be used to compare the images which are filtered, without original image. The images, to which filters are applied, are being compared by using the relationships between original images.

Impulsive Noise (IN) is the most widespread and important noise in digital images [3]. IN is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission through noisy channels. IN is categorized into two types: 1) SPN (Salt & Pepper Noise or Fixed Valued Impulsive Noise) and 2) RVIN (Random Valued Impulsive Noise). An aim of this study is to investigate and improve the techniques to deal with IN. Many filters are used and investigated for elimination of SPN [3]. The most common ones are median filter (MF) and adaptive median filter (AMF). These filters produce good results in IN elimination because of being order statistics filters. AMF is suitable when ratio of noise is high. Because of adaptive property, it has decision mechanism for determining if the pixel is noisy or not. But this mechanism reduces time performance. Despite of producing better results on images, that have low noise, than other filters, they are not preferred on images when time performance is significant.The noise properties of RVIN are different from the noise properties of SPN. Filters are used to eliminate this noise type and performances are compared. AMF may not eliminate well because of different noise types. Because IN elimination in digital images is aimed, the filters which are used on spatial domain and the filters that are in order statistic category will be investigated, improved and analyzed. More specifically, enhancement of time performance of AMF and the elimination of RVIN type noises by AMF are aimed.Impulse noise (IN) is corrupted to image by two different ways. One of them is SPN. In this noise types, there are 2 pixels which are corrupted in digital image. These 2 pixels are usually the minimum and the maximum values of the gray-level. Thus for 256 gray-level digital image, the minimum value is 0 and the maximum value is 255. The other one is RVIN. In this noise type, the noise pixels may be any value of the gray-level of digital image. The median filter was one the most popular nonlinear filter for eliminating impulsive noises because of its good de noising power and computational efficiency [5]. However, when the noise level is over 50%, some details and edges of the original image are smeared by the filter. Different remedies of the median filter have been proposed, e.g., the adaptive median filter [6], the multistage median filter [7], and the median filter based on homogeneity information [8], [9]. These so-called "decision-based" filters, firstly, identify possible noise pixels and then replace them by using the median filter or its variants, while leaving all other pixels unchanged. These filters are good at detection noise even at a high noise level. Their main drawback is that the noise pixels are replaced by some median value in their vicinity, details and edges are not recovered satisfactorily when the noise level is very high. A noise removal method by median-type noise detectors and detail-preserving regularization is proposed in [10]. In that method, SPN with noise ratio 90% can be cleaned quite efficiently, however its computation is huge.AMF does not work well for RVIN when noisy pixels are not the minimum and maximum pixel value in the image. Adaptive Median Filter **(** AMF) is an updated version of median filter. It successfully removes fixed valued impulsive noise types (salt & pepper noise) from image.A New Adaptive Decision Based Robust Statistics Estimation Filter for High Density Impulse Noise in Images and Videos has been recently proposed [9]. In this filter, the corrupted pixel is replaced by the median of the pixels in-side the filter window. If the median value is also an impulse, size of the window is increased for eliminating it. Although this filter eliminates impulse noise satisfactorily, it entails more computation time to perform filtering. A Highly Effective Impulse Noise Detection Algorithm for Switching Median Filters has been experimented [10].This algorithm has been shown to remove high density impulse noise. However, the computational complexity is quite high. A new proposed novel Switching Median Filtering Technique (SMFT) for removing impulse noise from the images is proposed. This filtering technique detects whether a pixel is noisy or noise-free. If the pixel is noise-free, the filtering window is moved forward to process the next pixel. On the other hand, if the pixel is a noisy one, then it is re-placed by the median pixel value if it is not an impulse; otherwise, the pixel is replaced by the already processed immediate top neighboring pixel in the filtering window. The proposed filter has been shown to exhibit good response at signal edges besides filtering out noise sufficiently.

3. IMPLEMENTATION AND DESIGN

3.1 Detection of Impulse Noise

The impulse noise detection is based on the assumption that a corrupted pixel takes a gray value which is significantly different from its neighboring pixels in the filtering window, whereas noise-free regions in the image have locally smoothly varying gray levels separated by edges. In widely used Standard Median Filter (SMF) and Adaptive Median Filter (AMF), only median values are used for the replacement of the corrupted pixels. In novel switching median filter, the difference between the median value of pixels in the filtering window and the current pixel value is compared with a threshold to determine the presence of impulse. If the current pixel is detected to have been corrupted by impulse noise then the pixel is subjected to filtering, otherwise, the pixel is left undisturbed as shown in Fig.3.2.2.1.

3.2 Block Diagram

The fig 3.2.1 shows the block diagram of switching median filter for image enhancement And explains about Peak signal to noise ratio (PSNR). The working of this consists of mainly 5 blocks are given by

- Noisy image
- Decision mechanism
- Filtering process
- Image restoration
- PSNR calculation

3.2.1 Noisy Image

The input is taken as a grayscale image and then adding a percentage of impulse noise i.e salt and/or pepper noise to the original image due to addition of this noise we will get a blurred, corrupted image is called noisy image.

3.2.2 Decesion, Filtering and Restoration Process

The filtering technique proposed in our paper detects the impulse noise in the image using a decision mechanism. The corrupted and uncorrupted pixels in the image are detected by comparing the pixel value with the maximum and minimum values in the selected window. If the pixel intensity lies between these minimum and maximum values, then it is an uncorrupted pixel and it is left undisturbed

Maximum values, then it is an uncorrupted pixel and it is left undisturbed

Step 4) If the central pixel lies between minimum and maximum values, then it is detected as an uncorrupted pixel

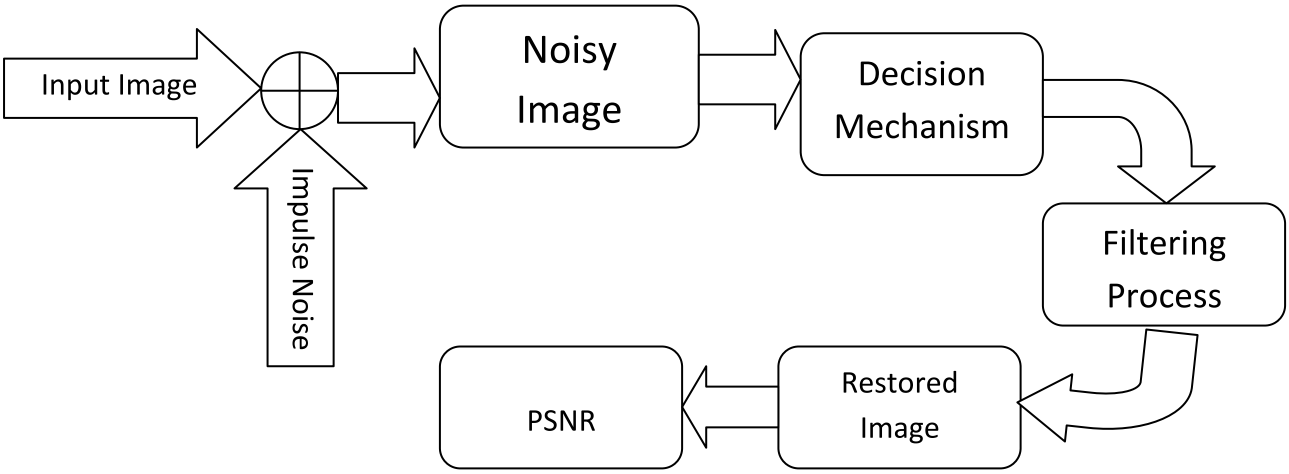


Fig 3.2.1 Block Diagram SMFT for image enhancement

If the value does not lie within the range, then it is a corrupted pixel and is replaced by the median pixel value or already processed immediate neighboring pixel in the current filtering window.

Consider an image of size M×N having 8-bit gray scale pixel resolution. The steps involved in detecting the presence of an impulse or not are described as follows,

Step 1: A two dimensional square filtering window of size 3x3 is slid over a highly contaminated image as shown in Fig 3.2.2.1.

Step2) The pixels inside the window are sorted out in ascending order.

0 159 162 163 **255** 255 255 255 255

161	**162**	**159**	**163**	**63**
167	**255**	**0**	**255**	**255**
164	**255**	**255**	**255**	**255**
165	**0**	**255**	**255**	**255**
166	**255**	**159**	**255**	**167**

Fig 3.2.2.1 sliding filter window of size 3 x 3 over noisy image

Step 3) Minimum, maximum and median of the pixel values in the processing window are determined. In this case, the minimum, maximum and median pixel values, respectively, are 0, 255 and 255

and the pixel is left undisturbed. Otherwise, it is considered a corrupted pixel value. In the present case, the central pixel value 255 does not lie between minimum and maximum values. Therefore, the pixel is detected to be a corrupted pixel.

Step 5) The corrupted central pixel is replaced by the median of the filtering window, if the median value is not an impulse. If the median value itself is an impulse then the central pixel is replaced by the already processed immediate top neighboring pixel in the filtering window. In the present case, the median value is also an impulse and therefore, the pixel is replaced by its already processed top neighbor pixel value 159.

The below Fig 3.2.2.2 shows the replacement of corrupted pixel. In this figure impulse noise value **0** is replaced by **159**.

161	**162**	**159** ⬇	**163**	**63**
167	**255**	**159**	**255**	**255**
164	**255**	**255**	**255**	**255**
165	**0**	**255**	**255**	**255**
166	**255**	**159**	**255**	**167**

Fig 3.2.2.2 Replacement of corrupted pixel.

Then the window is moved to form a new set of values, with the next pixel to be processed at the centre of the window. This process is repeated until the last image pixel is processed.

Finally at the end we are going to process the all the edges by morphological method.

3.3 Peak Signal to Noise Ratio (PSNR) and Experimental Results

The performance of proposed filter is compared with that of TMF by applying them on peppers, moon ,cameraman images, corrupted with various densities of impulse noise.

The objective measures used for quantitatively evaluating the performance of the filters are Mean Square Error (MSE) and Peak Signal to Noise ratio (PSNR) and these metrics are defined as follows,

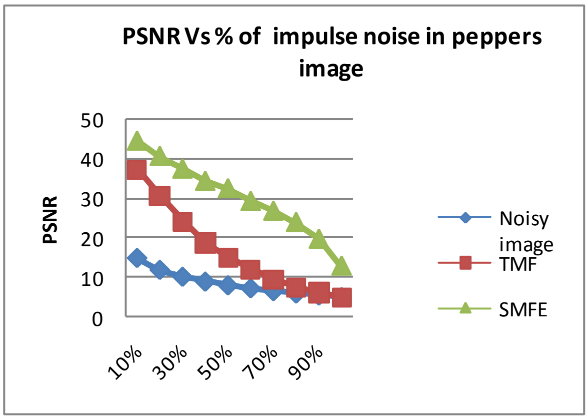
$$PSNR = 10 \log_{10}\left[\frac{255*255}{MSE}\right] \quad ......3.3.1$$

In order to prove the better performance of proposed filter, existing filtering techniques are experimented and compared with the proposed filter for visual perception and subjective evaluation on peppers ,moon ,cameraman images including the standard traditional Median Filter (TMF).

The values of objective measures obtained by applying the filters on peppers,cameraman test image contaminated with the impulse noise of various noise densities are summarized in Tables 3.3.1 to 3.3.2 and are illustrated graphically in Fig.3.3.1 to Fig.3.3.2

Table 3.3.1 PSNR of peppers image

Impulse Noise%	10	20	30	40	50	60	80	100
Noisy Image	15.03	12.00	10.24	8.99	8.038	7.30	5.96	5.03
TMF	37.30	30.74	24.24	18.89	15.16	12.06	7.72	5.12
NSMF	44.56	40.68	37.47	34.37	32.50	29.25	23.94	12.87

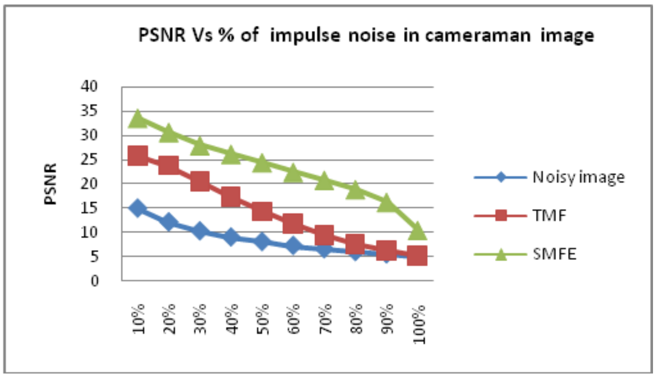


Presence of Impulse Noise

Fig.3.3.1PSNR Vs impulse noise of peppers image

Table 3.3.2 PSNR of cameraman image

PSNR / impulse Noise %	10	20	30	40	50	60	80	100
Noisy Image	14.96	12.13	10.29	9.04	8.09	7.30	6.03	5.10
TMF	25.83	23.74	20.52	17.39	14.34	11.78	7.64	5.15
NSMF	33.60	30.67	27.95	26.13	24.39	22.41	18.83	10.38



Presence of Impulse Noise

Fig.3.3.2PSNR Vs impulse noise of cameraman image Presence of Impulse Noise

4. CONCLUSION AND FUTURE WORK

A switching median filtering technique has been developed in this paper. The filter has been shown to be quite effective in eliminating the impulse noise. The filtering operation is performed only on corrupted pixels, uncorrupted pixels are undisturbed, as a result, misclassification of pixels is avoided. So that the proposed filter output images are found to be pleasant for visual perception and also the essential features of the images, namely, edges and fine details are preserved satisfactorily. The proposed filter has been shown to out-perform other existing filters in terms of noise elimination and feature preservation properties.

For a very high impulse noise contaminated image this filtering technique not completely removes the impulse noise still it will have impulses so it will be reduced in the future work by increasing the filtering window length and to achieve a higher peak signal to noise ratio.

For further improvement we are extending this to the combination of TMF and NSMF method.

5. ACKNOWLEDGEMENT

We the authors of this paper would like to gratefully acknowledge with thanks to head of E&TC department Prof. Dr.S.M.Mukane and Prof.Dr.B.P.Ronge, Principal SVERI's COE, Pandharpur, for constant encouragement and support for enabling us to submit this paper.

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