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Fixed Value Impulse Noise Removal In Medical Image By Modified Un Symmetric Trim Mean Filter

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Abstract:In last decade medical image quality improvement most popular topic for research. There are many methods are present for improving medical images. In the field of medical image processing, digital images very often get corrupted by several kinds of noise during the process of image acquisition. In this paper, we will present a new method for removal of impulse noise and enhancing magnetic resonance (MR) images quality. The method is based on eliminating impulse noise from MR images. A mean median-based method to remove impulse noise from digital MRI images has been developed. The method is adjusted in order to decide whether the median operation can be applied on a pixel. In this research, to suppress this deficiency, noisy pixels are initially detected, and then the filtering operation is applied on them. The proposed decision based unsymmetric mean median method (DBUMM) is simple and leads to fast filtering. The results are more accurate than other conventional filters. DBUMM detection stage a more powerful here we have use an alpha trimmed median filter for removal of noisy pixels. As a considerable advantage, some unnecessary median operations are eliminated and the number of median operations reduces drastically by using DBUMM. Decision based unsymmetric mean median filtering method leads to more acceptable results in scenarios with high noise density gives better peak signal noise ratio (PSNR) and better image quality. Furthermore, the proposed method reduces the probability of detecting noise-free pixels as noisy pixels and vice versa.

Keywords: Median filter, Impulse noise, Magnetic Resonance Image.

1. Introduction

In the field of medical images processing (MIP) digital images play an important role in some medical issues especially in detecting cancers, internal organs diseases and injuries. Some medical images are acquired based on Magnetic Resonance (MR) phenomenon used to investigate brain, liver and other soft tissues [1]. The study depends on the energy absorbing and emitting in the radio frequency range of the electromagnetic spectrum. MR images may be corrupted by some degrading phenomena during the acquisition process such as noise entering. Some degrading phenomena may contaminate MR images. It is based on the characteristics of MR phenomenon, image capturing equipment and some environmental influences. In this regard, impulse noise has an important corrupting influence impact on MR images. Removing noise from degraded images is a challenging research field in image processing. It involves estimation procedure of the image corrupted by noise [1]-[3].In this regard, nonlinear filters such as median filter are preferred as they can cope with the nonlinear property of the image model [2]-[4]. A typical form of impulse noise in a medical image is salt and pepper noise which represents itself as randomly occurring white (salt) and black (pepper) pixels. The noise density is a term used to quantify the amount of salt and pepper noise in an image. A total noise density of d in an MxN image means that dxMxN pixels contain noise. In general, if the total noise density of a salt and pepper noise is d, then it implies that each of the salt noise and the pepper noise has a noise density of $d/2$. It is possible that the salt noise and the pepper noise have different noise densities as $d1$ and $d2$, and consequently the total noise density is $d=d1+d2$.Impulse noise reduction can be achieved through the use of denoising filters. The median filter is a nonlinear digital filter which is often used in digital image processing to reduce noise in an image.

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In practice, besides reducing noise, it is important to preserve the edges of an image as edges provide critical information on the visual appearance of an image. Median filtering is a smoothing technique which is effective in reducing noise in the smooth regions of an image, but can adversely affect the sharpness in edges.As using the proposed filter, the noise bias can be removed and the original information can be successfully restored which outperforms three other methods both visually and in peak signal-to-noise ratio (PSNR).

Image enhancement: Image enhancement operation improves the qualities of an image. They improve an image's contrast and brightness characteristics, reduce its noise content or sharpen its details. Image enhancement techniques may be grouped as either subjective enhancement or objective enhancement. The subjective enhancement technique may be repeatedly applied in various forms until the observer thinks that the image yields the detail necessary for a particular application. Objective image enhancement corrects an image for known degradations. Here distortions are
known and enhancement is not applied arbitrarily. This enhancement is not repeatedly applied but applied once based on the measurements taken from the system. Image enhancement fall into two broad categories
as below:

· Spatial domain technique

· Frequency domain technique

Spatial domain refers to the image plane itself and approaches in this categories are based on direct manipulation of pixels in an image. Frequency domain processing techniques are based on modifying the Fourier transform of an image. Spatial domain refers to the total of pixels comprising an image. They operate directly on these pixels. Spatial domain processes will be denoted by the expression:

NOISE MODAL

Two common types of the impulse noise are the Fixed-Valued Impulse Noise (FVIN), also known as Salt and-Pepper Noise (SPN), and the Random-Valued Impulse Noise (RVIN). They differ in the possible values which noisy pixels can take [6]. The FVIN is commonly modeled by

$$(Y_{ij}) = \left\{ \begin{array}{ll} X_{i,j} & with\ probabilty \quad p \\ (0,255) & with\ probabilty \quad 1-p \end{array} \right\} \ldots\ldots\ldots\ldots\ldots(1)$$

Where x(i,j) and y(i,j) denote the intensity value of the original and corrupted images at coordinate (i,j), respectively and p is the noise density. This model implies that the pixels are randomly corrupted by two fixed extreme values, 0 and 255 (for 8-bit grey-scale images), with the same probability.

A model is considered as below:

$$(Y_{ij}) = \left\{ \begin{array}{ll} (0,m) & with\ probabilty \quad p1 \\ X_{i,j} & with\ probabilty \quad 1-p \\ (255-m,255) & with\ probabilty \quad p2 \end{array} \right\} \ldots\ldots\ldots\ldots\ldots(2)$$

Where p = p1 + p2. We refer to this model as Random valued Impulse Noise (RVIN).

LITERATURE REVIEW

Some existing filtering techniques
In this section, we provide the definitions of some existing filters. The image processing function in a spatial domain can be expressed as

g(p) =T(f(p))…………………….. (3)
Where T is the transformation function, f(p) is the pixel value (intensity value or gray level value) of the point p(x, y) of input image, and g(p) is the pixel value of the corresponding point of the processed image.

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Minimum filter

The minimum filter selects the smallest value within an ordered window of pixel values. An n x n window is overlaid on the upper-left corner of the image and the minimum is determined. This value is then put onto the output image in the position corresponding to the center location of the window. The window is slid one position to the right of the image and the process is repeated. As the end of a row is reached, the window is moved back to the left side of the image and filtering is thus done for the whole image. Salt noise appears as a set of white pixels. The intensity value of the white color is the highest of all colors. Since the minimum filter replaces the center pixel value by the smallest value of its neighborhood, this filter removes salt noise. This filter tends to darken the image. Minimum filter thus works well for the suppression of the salt noise. The transfer function of this filter is:

T(x, y) = min (f (xi, yi))……………….. (4)

Where xi, yi are the x and y co-ordinates of the neighboring pixels. f(xi, yi) is the intensity value of the neighbors. The value of 'i' varies from 1 to the size of the mask. For a 3 x 3 mask, the value varies from 1 to 9.

Maximum filter

The maximum filter selects the largest value within an ordered window of pixel values. Pepper noise appears of a set of black pixels. The intensity value of the black is the lowest of all colors. Since the maximum filter replaces the center pixel value by the largest value of its neighborhood, this filter removes pepper noise. This filter tends to brighten the image for the same reason. Maximum filter helps in eliminating the pepper noise. The transfer function of this filter is:

T(x, y) = max (f(xi, yi))……………. (5)

where xi, yi are the x and y co-ordinates of the neighboring pixels. f(xi, yi) is the intensity value of the neighbors. The value of 'i' varies from 1 to the size of the mask. For a 3 x 3 mask, the value varies from 1 to 9.

Median filter

Median filter reduces noise similar to the mean filter. The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used. Median filter controls the pepper and Gaussian noises. The median filter is reputed to be edge preserving.

Adaptive median filter

Traditional median filter doesn't take into consideration for how image characteristics vary from one location to another. It replaces every point in the image by the median of the corresponding neighborhood. In practice, adaptive filter that is capable of adapting their behavior depending on the characteristics of the image in the area being filtered can produce more effective output image for some input noisy images. An adaptive median filter whose behavior changed based on statistical characteristics of the image inside the filter region defined by the *m* x *n* rectangular windows *Sxy* is specified in theory [10]. Same as median filter, adaptive median filter also works in a rectangular window area S*xy*. Unlike median filter, however, the adaptive median filter changes the size of S*xy* during filter operation, depending on various conditions. The output of the filter is a single value used to replace the value of the
pixel at *(x, y).*

Consider the following notation:

Zmin = minimum intensity value in Sxy
Zmax = maximum intensity value in Sxy
Zmed = median of the intensity values in Sxy
Zxy = intensity value at coordinates (x, y)
Smax = maximum allowed size of Sxy

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The adaptive median filtering algorithm consists of two parts, denoted level A and level B: Level A: If Z min < Zmed < Zmax, go to level B Else increase the window size If window size < Smax, repeat level *A* Else output Zmed

Level *B:* If *Z* min < *Zxy* < *Z*max, Output *Zxy* Else output Z med Observing the algorithm, the purpose of level *A* is to determine if the median filter output, Zmed , is an impulse (black or white) or not. If the condition Zmin < Zmed < Zmax is true, then Z med cannot be an impulse according to the noise theory. In this case, go to level *B* and test if the point in the center of the window, Z*xy,* is itself an impulse. If the condition Z min < Z*xy* < Zmax is true, then Z*xy* cannot be an impulse. In this case, the algorithm outputs the unchanged pixel value, Z*xy*. By not changing these "intermediate-level" points, distortion is reduced in the image. If the condition *Z*min < *Zxy* < *Z*max is false, then either Z*xy* = Zmin or Z*xy* =Zmax. In either case, the value of the pixel is an extreme value and the algorithm outputs the median value Zmed, which we know from level *A* is not a noise impulse.

PROPOSED ALGORITHM

The proposed method is an enhanced by Modified Non-linear Filter (MNF) [03] algorithm. In this method first detecting the noisy pixels in the corrupted image. For detection of noisy pixels verifying the condition whether targeted pixel lies. If pixels are between maximum [255] and minimum [0] gray level values, then it is a noise free pixel, else pixel is said to be corrupted or noisy. Now we have processed only with the corrupted pixels to restore with noise free pixels. Further un-corrupted pixels are left unaffected. In the next steps we use Proposed Improved Mean filter (IMF) is elucidated as follows.

ALGORITHM

Step 1: First we take an initial image and apply on it fixed valued impulses noise (Salt and Pepper noise) on this image.

Step 2: In the second step check where the pixels are between 0 to 255 ranges or not, here two cases are generating.

X (i,j) = 0<Y (i,j)<255 condition true follow Case1

X (i,j) ≠ 0<Y (i,j)<255 condition true follow Case 2

Where X(i,j) is the image size and Y(i,j) all image targeted pixels

Case 1- If Pixels are between 0< Y (i,j)<255 then, they are noise free and move to restoration image.

Case 2- If the pixels are not lying between in the range then they are moved to step 3.

Step 3: In the third step we will work on noisy pixel of step2 now select window of size 3 x 3 of image. Assume that the targeted noisy pixels are W (i,j).that is processed in the next step.

Step 4: If the preferred window contains not all elements as 0's and 255's. Then remove all the 0's and 255's from the window, and send to restoration image.Now find the mean of the remaining pixels. Replace W (i, j) $_j$ with the mean value. This noised removed image restores in de-noised image at the last step.

W(ij) = [00] condition true send to Y (i,j) for Restoration

W(ij) = [255]condition true send to Y (i,j) for Restoration

[Cal. Mean remain (W (i,j))pixels] = replace by W (i,j)

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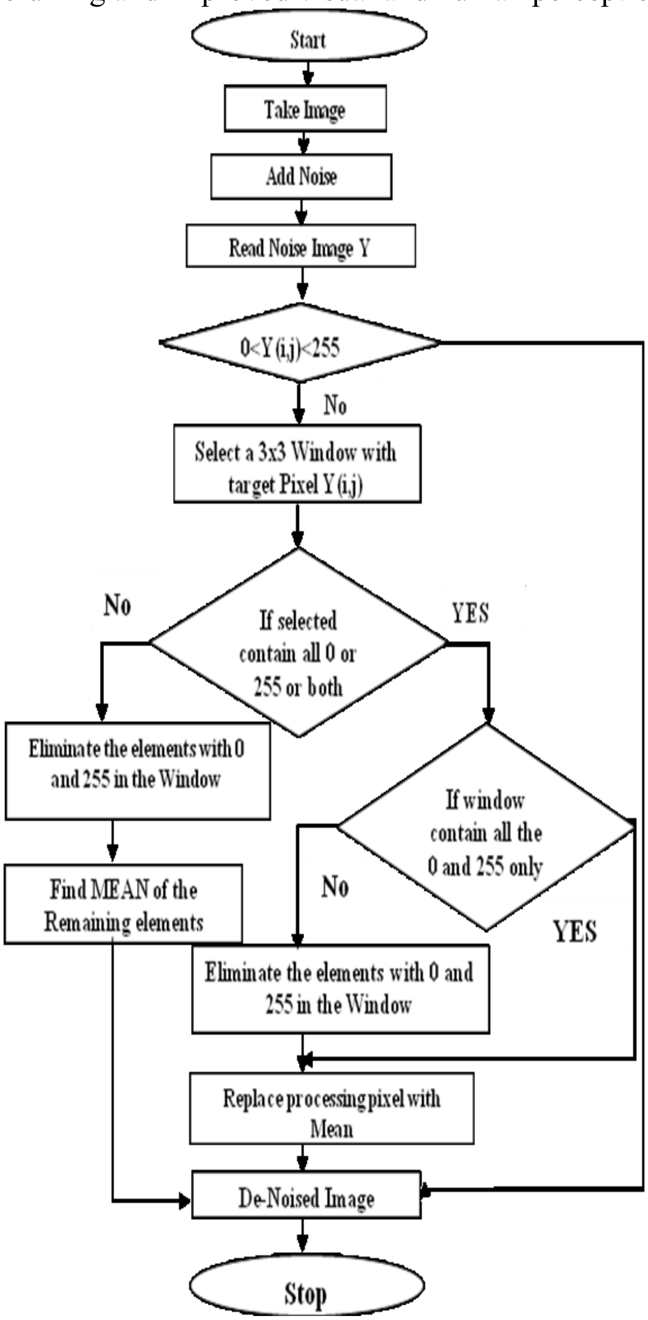
Step 5: Repeat steps one to three until all pixels in the whole image are processed. Hence a better de-noised image is obtained with improved PSNR, IEF and also shows a better image with very low blurring and improved visual and human perception



SIMULATION RESULTS AND COMPARISION

We have used MATLAB R2012b as the simulation tool. Performance of the proposed algorithm is tested with different grey scale and color images. The images are corrupted by fixed value impulse noise i.e. salt and pepper noise. Performances are quantitatively measured with various noise densities for Peak-Signal-to-Noise Ratio (PSNR), Mean Square Error (MSE) and Mean Absolute Error (MAE) defined (1), (2) and (3) respectively:

$$PSNR = 10\log_{10}\frac{(255)^2}{\mathrm{MSE}} \quad (1)$$

$$MSE = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\{Y(i,j)-\hat{Y}(i,j)\}^2}{m\times n} \quad (2)$$

$$MAE = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\left|Y(i,j)-\hat{Y}(i,j)\right|^2}{m\times n}$$

TABLE I

COMPARISON OF PSNR VALUES OF DIFFERENT FILTERS FOR LENA IMAGE

Noise Density %	MF	AMF	PSMF	DBA	MDBA	New Approach
10	28.4938	21.9845	30.6494	36.7565	36.7569	38.79
20	25.7542	21.9297	28.2089	33.2606	33.2607	35.59
30	21.8465	21.4735	25.559	30.5659	30.5308	33.26
40	18.4076	21.4735	22.6909	28.2609	28.2981	31.66
50	14.734	20.6542	19.4425	26.2846	26.2503	30.06
60	12.2348	18.4092	12.8511	24.5361	24.6321	28.56
70	9.9837	14.8564	10.5206	22.7798	22.9338	26.88
80	8.0229	11.2968	8.4849	20.1441	20.4098	24.85
90	6.5759	8.0603	6.7847	17.1205	17.2242	21.56

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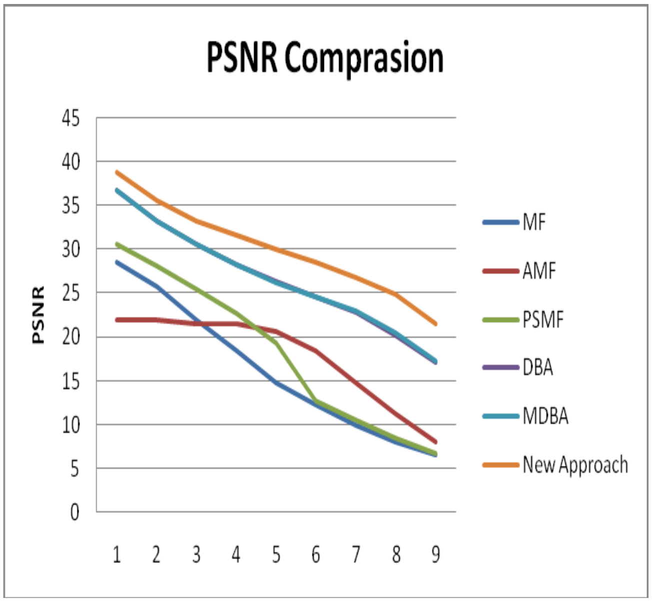
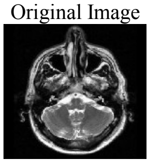
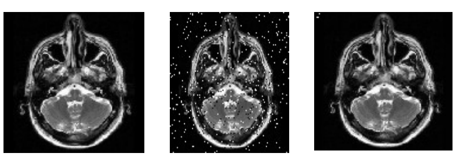


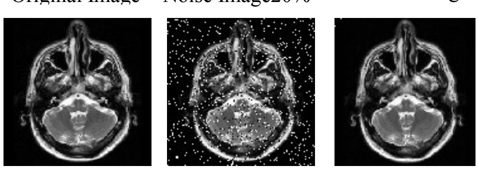
Original Image



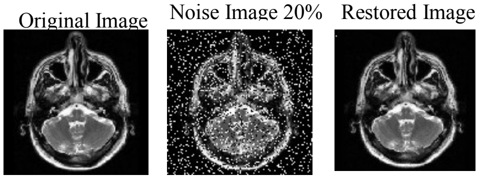
Original Image Noise Image 5% Restored Image



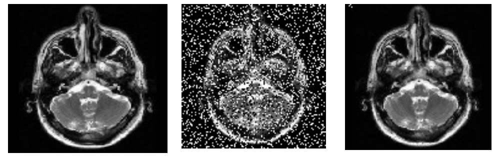
Original Image Noise Image20% Restored Image



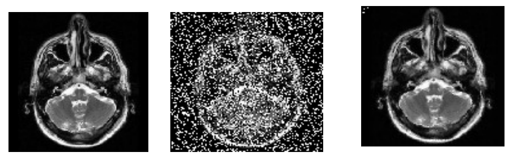
Original Image Noise Image 20% Restored Image



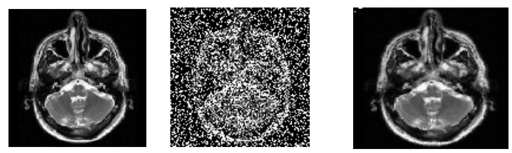
Original Image Noise Image 30% Restored Image



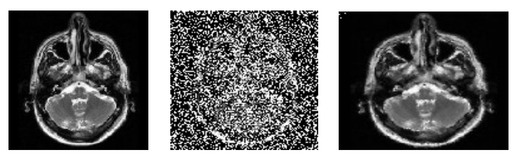
Original Image Noise Image 40% Restored Image



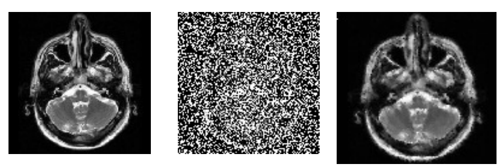
Original Image Noise Image 50% Restored Image



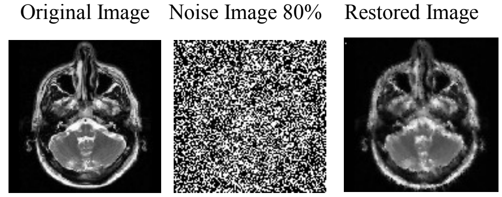
Original Image Noise Image 60% Restored Image



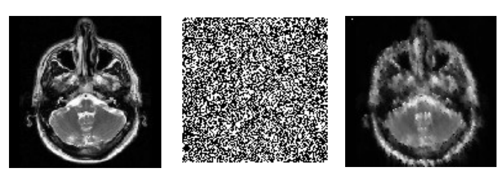
Original Image Noise Image 70% Restored Image



Original Image Noise Image 80% Restored Image



Original Image Noise Image 90% Restored Image



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CONCLUSION

In this paper we have proposed different types of noise and filtering method in the digital world. We show the different type of filter used in de-noising of different type of noises. In this paper, a new algorithm (UMTF) is proposed which gives better performance in comparison with MF, AMF, PSMF & DBA in terms of PSNR, MSE, and MAE. Proposed algorithm shows good denoising capability and can also preserve necessary details. Due to limited window size it requires less computation time. The performance of the algorithm has been tested at low, medium and high noise densities.

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