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De-noising MRI Image of High Density Different Noise using Linear and Nonlinear Threshold Filter

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ABSTRACT: In MRI images noise removal techniques have become an essential exercise in medical imaging applications, for the study of anatomical structures. MRI images are affected by Rician noise due to the magnitude image formation. Presence of Rician noise can significantly affect the image quality and contrast ratio of an image. In this paper Modified Median Filter technique is used for de-noising Rician noise. Rician noise displays varying distribution characteristic depending on the SNR of the image. Based on the probability distribution function of noise and SNR information obtained from the image, the proposed filter uses selection of filtering window of size 3X3 to perform de-noising. The proposed filtering technique has been implemented on MRI images. The efficiency of the proposed filtering technique is verified with a study of the PSNR characteristic of the de-noised and noisy image with respect to the true image. The proposed de-noising technique shows an improvement in the contrast ratio and PSNR of the noisy image.

KEYWORDS: Rician Noise, Median Filter, De-noising

I. INTRODUCTION

Presently multi day, a large portion of the data in Computer preparing is taken care of on the web. This online data is either graphical or pictorial in nature, and the capacity and correspondence prerequisites are tremendous. Thus technique for packing the information before capacity and transmission are of critical useful and business intrigue. Picture pressure implies diminishing the repetitive measure of information required to speak to an advanced picture. The Digital picture pressure in numerical structure can be characterized as change of a 2-D pixel exhibit by picture, into a factually uncorrelated informational collection. The change is connected on picture before capacity and transmission of Digital Image Data. The packed picture is recreated into unique picture by the procedure of Decompression. Decompressed picture can be a unique picture or estimation of it. Picture pressure is the innovation for dealing with the expanded spatial goals of the present imaging sensors and developing communicate TV norms. Picture pressure assumes an essential job in numerous critical and assorted applications including tele video conferencing, remote detecting, archive and medicinal imaging, copy transmission and the control of remotely guided vehicles in military, space, and risky waste administration applications. The application list is consistently developing the effective control stockpiling and transmission of various kinds of computerized picture, for example, paired pictures, dim scale pictures, and shading pictures and so forth [1], [2] The Internet, still in its youth; keeps on prospering and effect on our own and expert lives. Regular to these and numerous different applications is the prerequisite of immense extra room and correspondence transmission capacity for computerized pictures. Subsequently computerized media is persuaded by creative techniques for pressure of advanced pictures for productive use of extra room and correspondence data transfer capacity [3], [4]. As a rule setting, the picture talking pressure systems can be partitioned into two expansive classes: lossless pressure and lossy pressure plans. Lossless Compression (Information protecting): As the name suggests, this procedure includes no loss of information. The first information can be recuperated precisely from the compacted information.

CT check are on sort of unique x-beam tests which is produce cross-sectional pictures of the body utilizing PC and x-beams it connects a noteworthy job diagnosing medicinal infections, it is utilized to know subtleties of human body like chest, paunch, pelvis, arm, leg, by utilizing CT filter pictures of organ like liver, pancreas, digestive system, kidney, bladder, adrenal organ, lung and heart, and so on. The MRI is a systems to get a reasonable picture of organs by utilizing extensive measure of attractive and radio waves. It uses to analyze an assortment of conditions from tendons to tumors

and will be utilized to think about mind and spinal line. In restorative picture handling De-noising of pictures assumes an imperative job to get exact and precise pictures for further finding. Therapeutic pictures are gathered by various sensors and they are likewise oppressed wide assortment of mutilation, stockpiling, pressure, procurement, preparing, propagation And transmission which makes them get defiled by various kinds of clamors are evacuated utilizing channels as they can create best outcomes relying on its parameters. The determination of channels rely on they kind of commotion on the grounds that distinctive sort of clamor can be evacuated utilizing diverse kinds of commotions. In this paper a noised picture is considered and it is sifted utilizing Median and Wiener channel and the outcome is looked at on different parameters. Middle channel and Wiener channel calculation will be changed. Different clamors and like salt and pepper commotion are included. Wiener channel and middle channel are actualized to evacuate added substance commotion which is available in MRI and CT filters which likewise capable to include thickness step by step. Superconductive scanner contains refrigeration framework and fluid helium siphon which is in charge of "pound" sound, which is additionally aggravate patient and leads brief hoop misfortune.

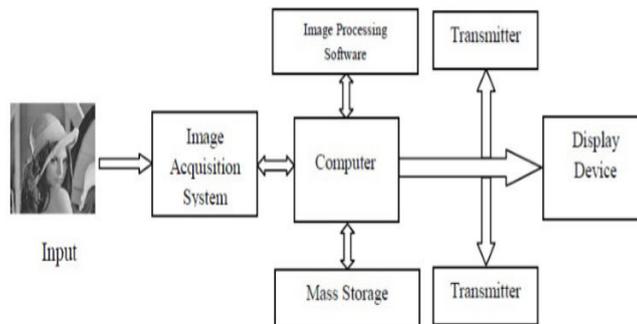


Figure 1: Typical Image Processing System

II. MRI IMAGE

X-rays utilize amazing magnets which produce a solid attractive field that powers protons in the body to line up with that field. At the point when a radiofrequency current is then beat through the patient, the protons are invigorated, and turn out of balance, stressing against the draw of the attractive field.

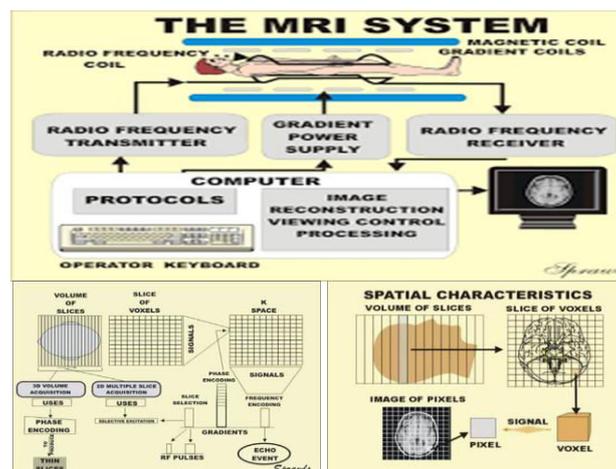


Figure 2: Working of MRI Image

At the point when the radiofrequency field is killed, the MRI sensors can identify the vitality discharged as the protons realign with the attractive field. Attractive polarization .Very solid uniform magnet excitation .Very amazing rf transmitter Acquisition, Location is encoded by inclination attractive fields .Very ground-breaking audi amps Polarization, Proton have an attractive minute proton have turns like pivoting magnets Body has a ton of protons.

III. PROPOSED METHODOLOGY

The Modified Median Filter calculation is the point at which a chose window contains just 0 and 255 esteem then the reestablished esteem is either 0 or 255 (again uproarious), drives us to proposed. In this calculation we chose pixel esteem 0 and 255 values then the preparing pixel is supplanted by mean estimation of the chose window. The detail of the calculation is given underneath.

Step-1:-

First we select all columns of filtering window one by one and then we find three values i.e. Maximum, Minimum and Median in each column. The mathematical expression can be shown as follow: The minimum values of rows and columns are represented as

$$\begin{aligned} \text{Min (cln1)} &= \min \{ Z1, Z4, Z7 \} \\ \text{Min (cln2)} &= \min \{ Z2, Z5, Z8 \} \\ \text{Min (cln3)} &= \min \{ Z3, Z6, Z9 \} \\ \text{Min (row1)} &= \min \{ Z1, Z2, Z3 \} \\ \text{Min (row2)} &= \min \{ Z4, Z5, Z6 \} \\ \text{Min (row3)} &= \min \{ Z7, Z8, Z9 \} \end{aligned}$$

The maximum value of rows and columns are represented as

$$\begin{aligned} \text{Max (cln1)} &= \max \{ Z1, Z4, Z7 \} \\ \text{Max (cln2)} &= \max \{ Z2, Z5, Z8 \} \\ \text{Max (cln3)} &= \max \{ Z3, Z6, Z9 \} \\ \text{Max (row1)} &= \max \{ Z1, Z2, Z3 \} \\ \text{Max (row2)} &= \max \{ Z4, Z5, Z6 \} \\ \text{Max (row3)} &= \max \{ Z7, Z8, Z9 \} \end{aligned}$$

The median value of the rows and columns are represented as

$$\begin{aligned} \text{Med (cln1)} &= \text{med} \{ Z1, Z4, Z7 \} \\ \text{Med (cln2)} &= \text{med} \{ Z2, Z5, Z8 \} \\ \text{Med (cln3)} &= \text{med} \{ Z3, Z6, Z9 \} \\ \text{Med (row1)} &= \text{med} \{ Z1, Z2, Z3 \} \\ \text{Med (row2)} &= \text{med} \{ Z4, Z5, Z6 \} \\ \text{Med (row3)} &= \text{med} \{ Z7, Z8, Z9 \} \end{aligned}$$

Step-2:-

Now we have total nine values (three maximum, three minimum and three median). We will use these values to calculate threshold values (maximum threshold and minimum threshold) and median value. For these calculations, we make three different groups of these nine elements.

$$\begin{aligned} \text{Max_group} &= (\text{Max (cln1)}, \text{Max (cln2)}, \text{Max (cln3)}, \text{Max (row1)}, \text{Max (row2)}, \text{Max (row3)}) \\ \text{Min_group} &= (\text{Min (cln1)}, \text{Min (cln2)}, \text{Min (cln3)}, \text{Min (row1)}, \text{Min (row2)}, \text{Min (row3)}) \\ \text{Med_group} &= (\text{Med (cln1)}, \text{Med (cln2)}, \text{Med (cln3)}, \text{Med (row1)}, \text{Med (row2)}, \text{Med (row3)}) \end{aligned}$$

First we will calculate max_min by choosing maximum value in min_group and min_max by choosing minimum value in max_group. Then we choose minimum threshold by choosing minimum value in max_group.

$$\begin{aligned} \text{max_min} &= \text{Max} (\text{Min (cln1)}, \text{Min (cln2)}, \text{Min (cln3)}, \text{Min (row1)}, \text{Min (row2)}, \text{Min (row3)}) \\ \text{min_max} &= \text{Min} (\text{Max (cln1)}, \text{Max (cln2)}, \text{Max (cln3)}, \text{Max (row1)}, \text{Max (row2)}, \text{Max (row3)}) \\ \text{median_med} &= \text{Med} \{ \text{Med (cln1)}, \text{Med (cln2)}, \text{Med (cln3)}, \text{Med (row1)}, \text{Med (row2)}, \text{Med (row3)} \} \end{aligned}$$

Now these three values (max_min, min_max, median_med) will be further sorted and finally we get minimum threshold, maximum threshold and final median value as follows:

$$\begin{aligned} \text{Thmax} &= \max \{ \text{min_max}, \text{median_med}, \text{max_min} \} \\ \text{Thmin} &= \min \{ \text{min_max}, \text{median_med}, \text{max_min} \} \end{aligned}$$



$$\text{Final_med} = \text{med} \{ \text{min_max}, \text{median_med}, \text{max_min} \}$$

These two threshold values will be used for noise detection and final median will be used for noise removal.

Step-3:-

Now we will perform noise detection and noise removal operation using these three values i.e. Thmax, Thmin, and Med_new. We compare the central pixel with threshold values. If the central pixel is in between the Thmin and Thmax, then the pixel will be considered as noise free, then pixel will remain unchanged and window will move or slide to the next pixel. Otherwise pixel will consider as noisy and it will be replaced by median value.

If $\text{Thmin} \leq Z5 \leq \text{Thmax}$
Then Z5 is unchanged.
Else $Z5 = \text{Med_new}$.

Here we are parallely calculating the threshold values and median value. So there is no need to perform noise detection and noise removal separately.

IV. SIMULATION RESULT

The proposed calculations are tried utilizing 256x256 8bit/pixel picture bike.jpg. In the reproduction, pictures are tainted by Salt and Pepper commotion. The commotion level shifts from 10% to 90% with augmentation of 10% and the execution is quantitatively measured by Mean square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

The PSNR value approaches as high as possible the MSE approaches to zero; these results show that a higher PSNR value provides a better image quality. At the other end of the parameter, a small change in the PSNR indicates high numerical differences between image qualities. PSNR is usually represents in terms of the logarithmic decibel scale. Mean Square Error (MSE)

$$MSE = \frac{1}{N_1 N_2} \sum_{j=1}^{N_2} \sum_{i=1}^{N_1} (f(i, j) - g(i, j))^2 \tag{1}$$

Root Mean Square Error (RMSE)

$$RMSE = \sqrt{MSE} \tag{2}$$

Normalized Absolute Error (NAE)

$$NAE = \frac{1}{N_1 N_2} \sum_{j=1}^{N_2} \sum_{i=1}^{N_1} (f(i, j) - g(i, j)) \tag{3}$$

Where,

- N_1 = Row Dimension of Image
- N_2 = Column Dimension of Image
- $f(i, j)$ = Original Image
- $g(i, j)$ = De-noising Image
- Signal to Noise Ratio

$$SNR = 20 \log_{10} \left(\frac{\sum_{j=1}^{N_2} \sum_{i=1}^{N_1} (f(i, j) - g(i, j))}{MSE} \right) \tag{4}$$

Peak Signal to Noise Ratio (PSNR)

$$PSNR = 10 \log_{10} (N_1^2 \times N_2 / MSE)$$

Universal Image Quality Index (UIQI)

$$UIQI = \frac{4 \times u_x \times u_y \times u_{xy}}{(u_x^2 + u_y^2) + (\sigma_x^2 + \sigma_y^2)} \tag{6}$$

Where,



u_x = Mean of Input Image
 u_y = Mean of Output Image
 σ_x = Standard Deviation of Input Image
 σ_y = Standard Deviation of Output Image

Table1: Comparison of different parameter with Different salt and Pepper Noise Density for Spinal Cord Image

Noise Density (J/K)	NAE	MSE	RMSE	SNR	PSNR	UIQI
0.01	0.004	0.03	0.18	11.88	62.70	0.004
0.02	0.01	0.07	0.27	11.29	59.48	0.009
0.03	0.01	0.11	0.33	10.94	57.63	0.0014
0.04	0.02	0.15	0.38	10.67	56.35	0.0019
0.05	0.02	0.19	0.44	10.50	55.28	0.0023
0.06	0.03	0.24	0.49	10.34	54.32	0.0028
0.07	0.03	0.28	0.53	10.22	53.56	0.0033

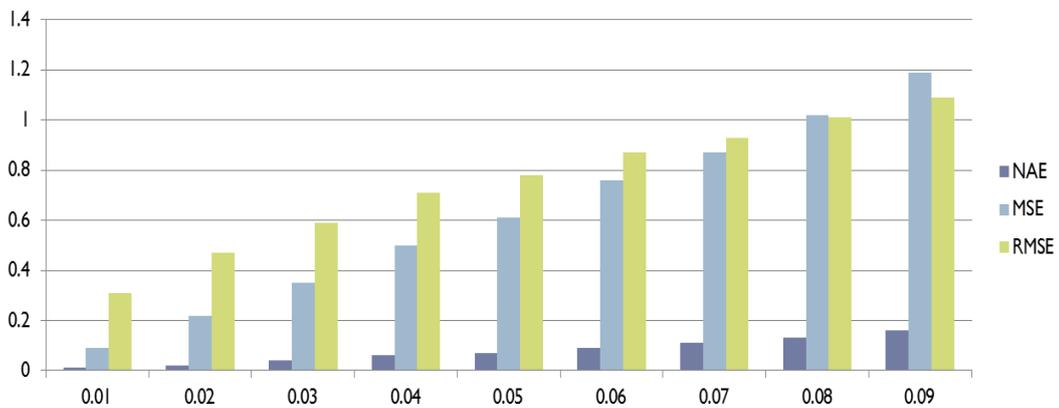


Table 2: Comparison of different parameter with Different Speckle Noise Density for Brain Image

Noise Density (J/K)	NAE	MSE	RMSE	SNR	PSNR	UIQI
0.01	0.01	0.11	0.34	11.79	57.50	0.003
0.02	0.03	0.26	0.51	11.21	54.00	0.006
0.03	0.05	0.44	0.66	10.85	51.66	0.009
0.04	0.07	0.62	0.79	10.62	50.17	0.0013
0.05	0.10	0.85	0.92	10.42	48.86	0.0017
0.06	0.13	1.07	1.03	10.29	47.29	0.002
0.07	0.16	1.29	1.13	10.16	47.04	0.0023
0.08	0.20	1.60	1.26	10.05	46.11	0.0027
0.09	0.24	1.83	1.35	9.97	45.53	0.003

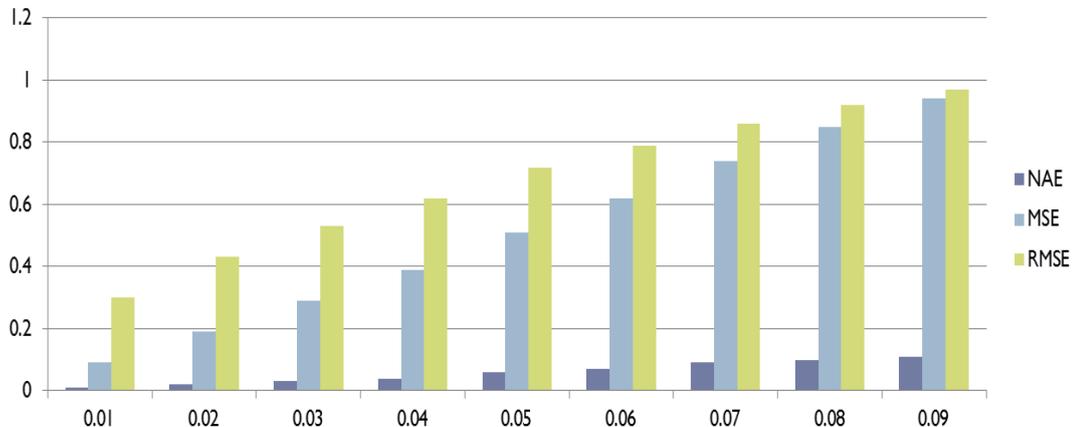


Figure 4: Bar Graph of the Error for Different Speckle Noise Density

V. CONCLUSION

The proposed filter has proved that it is very efficient for random valued impulse noise because practically noise is not uniform over the channel. In this dissertation is used concept of maximum and minimum threshold to detect both positive and negative noise. It produces improve PSNR (Peak Signal to Noise Ratio) and very small MSE (Mean Square Error) for highly corrupted images, especially for more than 50% noise density.

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