TEST Engineering & Management

January - February 2020
ISSN: 0193-4120 Page No. 4629 - 4633

A Continuous Decision Based Multi Kernel Median Filter for Noise Removal on Brain MRI Images

Dr.V.P.Gladis Pushparathi [1], Dr. M. Sudha [2], D. Jasmine David[3], Dr. K. Anbazhagan[4]

S. Ezra Vethamani[5]

[1, 4] Associate Professor, Department of Computer Science and Engineering, Velammal Institute of Technology, Panchetti – Chennai

[2] Assistant Professor, Department of Electronics and Communication Engineering, SASTRA deemed to be University ,Kumbakonam

[3] Assistant Professor, Department of Electronics and Communication Engineering, Karunya Institute of Technology and Sciences, Coimbatore, India

[5] Assistant Professor ,Department of Computer Science and Engineering, Velammal Institute of Technology, Panchetti – Chennai

Article Info
Volume 82
Page Number: 4629 - 4633
Publication Issue:
January - February 2020

Article History
Article Received: *18 May 2019*
Revised: *14 July 2019*
Accepted: *22 December 2019*
Publication: *23 January 2020*

Abstract

Impulse noises in images are caused by bit errors in transmission and signal acquisition. Salt and pepper noise and random noise are also known as Impulse Noise. As per the statistical analysis of noise in Brain MRI image shows salt and pepper noise is one of the most common which affect the accuracy of the tumor detection. Many nonlinear algorithms have been proposed to remove salt and pepper noise. But without damaging the edges is the difficult Task. Noise removal without damaging the edges is proposed in this paper. If the noise density increases, the effectiveness of the filter will be decreased. This is the major drawback of the existing algorithms. This paper discusses many noise removal techniques and proposes a novel noise removal technique using Continuous Decision Based Multi Kernel Median Filter (CDBMKMF). The proposed CDBMKMF algorithm attempts to eliminate noise in high noise density images with better PSNR values. Image pixels are checked for the occurrence of salt and pepper noise and removed effectively. Using Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR), the proposed methods are validated and compared with existing algorithms. This paper also evaluates the proposed algorithm with standard and unsymmetrical median filters.

Keywords; *Noise Removal, CDBMKMF, unsymmetrical median filter, standard median filter*

I. INTRODUCTION

The transmission and signal acquisition are the causes to create impulse noise in images. The usual value for the pepper noise is 0 and for the salt noise is 255. The corrupted pixels take either maximum or minimum gray level value. The filters are used to restore the image with the originality. The noise reduction processes reduces the noise level of the image and enhance the performance and output. If the quality of input image is enhanced then the overall performance quality is sure to improve [1],[3],[5].

Advanced imaging equipments like CT, MRI and PET are used to acquire Medical images. Disturbances in these devices or human errors can often corrupt these images by noise and distortion leading to lesser accuracy step for medical image processing levels [9],[10],[11],[12]. Filter the image for smoothing an image or removing noise would be the primary step of any medical image preprocessing

January - February 2020
ISSN: 0193-4120 Page No. 4629 - 4633

to enhance the image features like preserving edges and image density details.

Median filter is widely used to take away the impulse noise which is one of the most common noise sources in image processing. Pixel value deviations from originals in images produce erroneous intensity in an image and are caused at any stage of image processing like image capturing and image transmission. Removal of noise is an essential aspect of image qualitative processing, since they influence subsequent processing tasks like image segmentation [2],[4],[6]. Image noise has various names and reasons like Amplified noise, (example Gaussian noise), Salt and pepper noise (example Impulse noise), Quantization noise (example uniform noise), Speckle noise (example Multiplicative noise) and Periodic noise etc.

The salt and pepper noise is caused due to fault memory locations, digitization timing errors and malfunctioning camera pixels. It takes only two values with the probability of lesser than 0.2 for each and Values greater than 0.2 is dangerous to any image. The salt and pepper noise value in an 8 bit image is 0. Filters are used to suppress noise while preserving the originality in an image[7],[8].

Filtering is a regular process used by image processing systems, where the nature of the task defines the choice of the filter. For Example Gaussian filters remove noise, but blur image edges or other inner details of an image. Many nonlinear median filters have been proposed in the recent past to overcome filtering shortcomings. The proposed algorithm is presented in Section II and results are discussed in section III while Section IV in conclusion.

II. PROPOSED METHOD

Median Filter is an easy and dominant nonlinear filter based on order statistics. It smooths the images and is mainly used for reducing intensity variations in pixels. The noisy pixel value replacement is not based on the neighboring pixel's mean values, but the value of median. The values are stored and sorted using ascending order method and the middle value is chosen as the replacement value. For even number of pixels, the average of two middle pixel values is taken as replacement value. This filter is best when used for noise less 0.1 %, can be used for low noise densities and loses edges when noise density is greater than 50%. Switching median filters use a pre-defined threshold value, making it difficult to a robust filter. Most of the filters do not take local features into consideration, making recovery of edge details in an image a very difficult task.

A Decision Based Algorithm (DBA) can overcome this drawback. It uses a 3*3 window for denoising an image and processes only pixels with values of 255 or 9. The median value of the high noise dense image will either be a 0 or 255. To generate a streaking effect the neighboring pixel value is replaced in the noisy pixels. When the window contains 0's or 255's or both in high noise density images, the value of trimmed median cannot be obtained, thus reducing quality in noise densities of 80% to 90%. This drawback is removed by Modified Decision Based Unsymmetrical Trimmed Median Filter (MDBUTMF).

The proposed Continuous Decision based Multi Kernel Median Filter (CDBMKMF) algorithm attempts to eliminate noise in high noisy images with better PSNR values. The presence of the salt and pepper noise is checked for each and every pixel of the image and removed very effectively. Some sample cases of noise densities are taken into consideration and explained below. The MRI image is given as an input to the noise reduction process. The entire value of the image is processed to make the image noise free. Consider a processing pixel P(i,j) which is located at the horizontal position j and vertical position i, and is processed for total noise reduction in three cases.

In case 1, the processing pixel is checked whether it is in the range 1 to 254. Then the pixel is left without modification otherwise the process moves to either case 2 or case 3. In case 2, 3x3 overlapped window is chosen for noise reduction. The sum of noise free pixel around the center pixel is computed. If the count is greater than or equal to 3 then the

Published by: The Mattingley Publishing Co., Inc.

processing pixel is accommodate by the median value. If the count is equal to 2 then 5x5 window elements are chosen, after that the second order noise free (muted) pixel count is identified. Even if one noise free pixel appears then the process moves to find the median (M1) of the 5x5 window.

A 3x3 window which is centered by the processing pixel is formed. The mean (M2) of the two first order muted pixels is computed and then the average value M3 is evaluated from the M1 and M2 which is used to change the current processing pixel P(i,j). If the non-availability of the second order muted pixel count is found, then the mean (M3) of the two first order muted pixels is used to reduce the noise of the current pixel P(i,j). If the count of muted pixels in the first order is found as 1, then the 5x5 overlapped window elements are extracted. If any muted pixel appears in the second order elements then the median of second order muted pixels are computed as M4 and it is used to swap the current noisy pixel P(i,j). Otherwise the single noise free pixel of first order is used to swap the current noisy pixel P(i,j).

The 5x5 overlapped window elements are extracted and it is checked for the existence of at least one first order noise free pixel. If there are no noise free first order pixels, then the existence of noise free pixel in the second order is verified. If at least one noise free second order pixel is found, then the mean value is used to swap the current noisy pixel. Else, the average of the entire first order noisy pixel is calculated and it is used for the elimination of noisy pixel.

CDBMKMF checks the entire image for impulse noise. If the processing pixel value is between 0 and 255 is illustrated in Case i. If at least any one of the neighbor is noise free is illustrated in Case ii. If all the first order neighbor pixels are noisy is illustrated in Case iii.

Case i) If the processing pixel is 0<P(i,j)< 255 then leave as it is

Case ii)Take a 2D 3*3 window. If at least any one of the neighbor is noise free pixel then do the following steps

(i) If the C(NFP) ≥ 3 then find the median and do replacement
(ii) If the C(NFP)=2 then find the 5*5 window. Eliminate the noisy pixels of second order elements.

If the second order C(NFP) > 0 then

(a) Find the median of 5*5 called as M1
(b) Find the 3*3 window and eliminate the noisy pixels of first order
(c) Find the mean of the two muted pixels that is called as M2
(d) Find the average of M1 and M2. The value is called as M3
(e) Do replacement

Else

(a) Find the mean of the two first order muted pixels of 3*3 window first order
(b) Do replacement

(iii)If the first order C(NFP) =1 then

Find the 5*5 window and eliminate the noisy pixel

(iv)If the second order C(N F P) >0 then

Find the median of noise free pixels M1.

Else

Noise free pixel value M2= single pixel of muted first order

Do replacement with M2

Case iii) Take 3*3 window. If all the first order neighbor pixel are noisy then do the following step

(i) Find the 5*5 window. Eliminate the second order muted pixel

If the C(NFP) > 0 then find the mean of them as called M1

Do replacement with M1

Else

Find the mean of first order noisy pixel called M2

Do replacement with M2

III. EXPERIMENTAL RESULTS

Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) are the two parameters which are used to check the performance of the proposed algorithms

3.1 Proposed algorithm validation results using MSE

Five images from the image database were taken for Mean Square Error calculation. Table 1 lists the Calculated MSE values of the 5 images using the existing methods and the proposed method

Table 1 - Calculated MSE values for the proposed and existing methods

S.NO	Image	Mean Square Error		
		Standard Median filter	Unsymmetrical median filter	Proposed Method
1	MRI_IMG1	0.1010	0.0192	0.0080
2	MRI_IMG2	0.1229	0.0182	0.0120
3	MRI_IMG3	0.0195	0.0240	0.0112
4	MRI_IMG4	0.0198	0.0275	0.0120
5	MRI_IMG5	0.0790	0.0228	0.0122

MSE values were obtained by applying the existing Standard Median Filter and Unsymmetrical median filter by MAT Lab. The MSE values in table 1 indicate that the MSE as calculated by Standard Median filter is the highest for MRI_IMG1, MRI_IMG2, MRI_IMG5. For MRI_IMG3 and MRI_IMG4 MSE is higher for Unsymmetrical median filter, while MSE obtained using the proposed method is the lowest for all the images.

3.2 Validation of the proposed method using Peak Signal Noise Ratio (PSNR)

Five images from the image database were taken for PSNR analysis. PSNR values obtained using the above 3 methods are shown in table 2. PSNR values were obtained by using MAT Lab for the existing methods and proposed method. The PSNR values of table 2 clearly indicate that the PSNR as calculated by Standard Median filter is the lowest for all five input images. However, PSNR obtained using the proposed method is the highest for all the images.

Table 2 - Calculated PSNR values for the proposed and existing methods

S.NO	Image	Peats Signal to Noise Ratio		
		Standard Median filter	Unsymmetrical median filter	Proposed Method
1	MRI_IMG1	56.1205	62.1346	65.5682
2	MRI_IMG2	55.4238	61.2287	64.6128
3	MRI_IMG3	63.4632	65.1205	65.2778
4	MRI_IMG4	63.5678	62.2926	66.3698
5	MRI_IMG5	58.1234	63.7865	65.9856

3.3 Comparison by Quality Index using Eye Perception

Table 3, depicts the Quality Index of the proposed and existing methods using eye perception for all the five images. The proposed method's eye perception quality index for all the five images was 3, proving the noise removal process employed by the proposed method is achieved better-quality when compared to existing methods.

Table 3 - Quality Index of the proposed and existing methods using Eye Perception

S.NO	Image	Quality Index		
		Standard Median filter	Unsymmetrical median filter	Proposed Method
1	MRI_IMG1	1	2	3
2	MRI_IMG2	1	2	3
3	MRI_IMG3	2	1	3
4	MRI_IMG4	2	1	3
5	MRI_IMG5	1	2	3

CONCLUSION

An novel and efficient noise removal algorithm in medical image processing is proposed and proved. The results are shown lesser mean square error, higher peaks signal to noise ratio when compared to the existing methods. Also the quality analysis using eye perception is showed that the proposed method will be useful for noise removal. The proposed approach will perform best when the objects of interest in the image are well defined, with strong edges and uniform background, thus making it an elective to image segmentation algorithms.

REFERENCES

[1] Upma, Rekha et.al, "A New Methodology for Salt and pepper Noise Removal in Digital Image Processing", IJFCST, Vol.5, No.1, Jan 2015 PP. 66-73

[2] Garg, Verma et al "A Survey Paper on Various Median Filtering Techniques for Noise Removal from Digital Images" AIJAR 7 Vol. 1, Aug 2014, PP. 43-47

[3] Lin G C, Wang W J, Kang et al, "Multispectral MR Images segmentation based on fuzzy knowledge and modified seeded region growing", Magnetic Resonance Imaging, Vol. 30, No. 2, 2012 ,PP. 230-246

[4] Pinaki, Mukherjee, et al "Digital Image Segmentation Using Median Filtering and Morphological Approach", IJARCSSE, Vol. 4, No. 1, Jan 2014, PP: 552-557

[5] Suman ,Shrestha ," Image Denoising Using New Adaptive based Median Filter" SIPIJ, Vol.5, No.4, Aug 2014,PP.1-13.

[6] Patidar , Gupta et.al, "Image De-noising by Various Filters for Different Noise", IJCA, ,Vol. 9, No.4, Nov 2010,PP.45-50.

[7] V N Prudhvi Raj et al "Denoising of Medical Ultrasound Images Using Spatial Filtering And Multiscale Transforms" ,IJCSIT, Vol 4, No. 6, Dec 2012, PP.169-190.

[8] Fred and Kumar et al "A Novel Filter Selection for Efficient and Robust Segmentation in MR Human Brain Images Through Comparative Analysis of Various Spatial and Transform Domain Filters", IJERT ,Vol. 3 No. 5, May 2014, PP.582-586.

[9] GladisPushpaRathi, VP, Palani, S et al, "An Early Stage of Brain Tumor Detection and Growth Calculation Using Eight Axis Division Technique", IJAER, Vol. 10, No. 4, 2015 PP. 8757-8771.

[10] GladisPushpaRathi, VP, Palani, S, "Brain Tumor Detection and Classification Using Deep Learning Classifier on MRI Images" RJASET, Vol. 10, No. 2, 2015, PP. 177-187.

[11]. GladisPushpaRathi, VP, Palani, S et al , "A Novel Approach for Brain Tissue Area Detection Using Discrete Wavelet and Sequence Mean Computation", IJAER, Vol. 10, No. 29, 2015, PP. 22579-22590.

[12]. GladisPushpaRathi, VP, Palani, S, "Efficient Analysis of Brain Tumor From MRI Image Using K-means Clustering and Neural Network", Australian Journal of Basic and Applied Sciences, Vol. 9, No. 7, 2015,PP 110-112.

[13]. GladisPushpaRathi, VP, Palani, S, "Brain Tumor MRI image Classification With Feature Selection And Extraction Using Linear Discriminant Analysis", IJIST, Vol 2.,No:4, 2012, PP:131-146.

[14] GladisPushpaRathi, VP, Palani, S , "A Novel Approach For Feature Extraction And Selection On Mri Images For Brain Tumor Classification", CCSEA, CS & IT-CSCP, 2012 , PP: 225-234

[15] GladisPushpaRathi, VP, Palani, S , "Linear discriminant analysis for brain tumor classification using feature selection", IJCSE, 2012, Vol:5, No.5.

[16] GladisPushpaRathi, VP, Palani, "Detection and characterization of brain tumor using segmentation based on HSOM, wavelet packet feature spaces and ANN", ICECT, 2011, PP:274-277.