Asian Journal of Computer Science and Technology
ISSN: 2249-0701 (P) Vol.7 No.2, 2018, pp.107-112

DOI: https://doi.org/10.51983/ajcst-2018.7.2.1870

A Novel Pre-Processing Approach for the Denoising of Alzheimer Disease Image Dataset

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(Received 12 July 2018; Revised 25 July 2018; Accepted 12 August 2018; Available online 18 August 2018)

***Abstract* - Medical imaging doing an indispensable part in the area of medicine. Noise in the image is maddening as it worsens the quality of image. Thus, removal of noise is perpetually a problematic work in the images of all domain. Alzheimer's disease, a neurological dysfunction in which destruction of cells in brain creates mental weakening and memory loss. The distinguished reason for Alzheimer's disease is low brain activity and low blood flow. We proposed a framework for removal of noise in Alzheimer disease image using histogram equalization, thresholding, open morphological operation and a wavelet transform. This framework reduces the noise and significantly better than the existing methods used for Alzheimer disease images.**
***Keywords:* Thresholding, Histogram Equalization, Wavelet transform, Denoising**

I. INTRODUCTION

In the nation, more than 400 thousand individuals have Alzheimer's malady (AD) [1] (around 6% of the populace). One of every six nations above age 60 has determined to have an AD, and it is the fourth pouring reason to death. An ideal analysis is not feasible until medium to critical cortex loss has happened. By consuming image processing approaches [2], Alzheimer locale can take by using a blend of denoising, feature extraction, segmentation and classification techniques. The proposed pre-processing technique has the capability of supporting in medicinal examination.

II. RELATED WORKS

The authors in [3] obtain a picture noise filter fitting for MRI continuously (show and securing), which ensures modest disengaged points of interest and effectively kills condition noise without presenting obscure, spreading, or fix ancient rarities.

The authors in [4] presented a three-advance structure for grouping multiclass radiography pictures. The initial step uses a de-noising system in light of wavelet transform (WT) and the measurable Kolmogorov Smirnov (KS) test to expel noise and inconsequential highlights of the pictures. An unsupervised deep conviction organize has made for taking in the unlabeled highlights in the second step. The mix of WT and KS test in initial step enhances the execution of DBNs. Discriminative element subsets got in the initial two stages fill in as contributions to classifiers in 3rd step for assessments.

The authors in [5] clarified the trans-spiral coronary angiography (TRA) has related with expanded radiations dosages. The authors estimated that contemporary picture decrease technology would diminish radiation measurements in the cardiovascular catheterization research center in regular clinical setting.

The authors in [6] introduced algorithm comprises of two phases in which the principal arrangement distinguishes whether motivation noise has ruined pixels and the second stage plays out a filtering operation on the recognized boisterous pixels. Tentatively, it has discovered that the proposed conspire yields a superior Peak Signal-to-Noise Ratio (PSNR) contrasted with other existing median-based motivation noise filtering plans.

The authors in [7] clarified an ideal versatile worldwide limit choice by boosting between-class standard deviation through histogram peak examination to get a coarse division. This paper examines another PC supported way to deal with recognize the anomalies in the computerized mammograms utilizing a Dual Stage Adaptive Thresholding (DuSAT).

The authors in [8] proposed an algorithm for different watermarking in view of discrete wavelet transforms (DWT), discrete cosine transform (DCT) and solitary esteem deterioration (SVD) for social insurance applications. For personality validation reason, the proposed technique utilizes three watermarks as therapeutic Lump picture watermark, the specialist signature/distinguishing proof code and the demonstrative data of the patient as the content watermarks.

The authors in [9] proposed a technique which utilizes KNN and high lift filter. The KNN classifier is utilized to choose skin and non-skin pixel, and afterward a high lift filter approach is connected which can dispense with the noise and obscure from the picture.

The authors in [10] proposed a hybrid drive noise filter, it has executed in two stages, in the primary stage, fuzzy rules are utilized to recognize the pixels influenced by motivation noise, and in 2nd stage, a fake neural system is utilized to expel noise from the influenced pixel. The authors in [11] proposed the Medav Filter which is a mix of mean and versatile median filter that ideally changes the level of mask operations as indicated by the noise density. The median filter has great noise removal characteristics, however its multifaceted nature is unwanted.

Thus, in the literature number of different mechanisms has been adopted to remove noise from the images so far. However, the level of noise removal is limited to certain extent and in specific eliminating noise from the Alzhemier's image dataset is much more challenging and very important task for disease diagnosis. Hence in this work, we adopted the combination of histogram equalization, thresholding, open morphological operation and a wavelet transform for denoising in Alzhemier image.

III. ALZHEIMER DISEASE

Alzheimer's is a dynamic illness, where dementia indications step by step exacerbate over numerous years [12]. In its commencement times, memory loss is mellow, yet with late arranges Alzheimer's, people lose the capability to bear on conversation and respond to their situation. Alzheimer's is sixth driving cause to death in United States. Alzheimer's has no contemporary cure however medications for symptoms are accessible and investigate proceeds. Although current Alzheimer's medicines can't prevent Alzheimer's from growing, they can incidentally moderate the intensifying of dementia side effects and enhance personal satisfaction to those having Alzheimer's and their parental figures. Today, there is general exertion under the methods to develop better approaches to cure the disease, postpone its commencement, and keep it from generating.

Alzheimer is the aggregate brain measure contracts, and tissue has rationally less nerve cells and associations. Subsequently, this is cause to in bring down reasoning and infrequent issues of recalling certain things. The Alzheimer's Association says in its initial beginning data that specialists don't hope to discover Alzheimer's ailment in more youthful individuals. For the more youthful age gatherings, specialists will search for other dementia causes first [1, 13].

Visualization of brain structure and capacity from the level of individual atoms to the entire brain [14]. Many imaging strategies are noninvasive and enable unique procedures to be screen after some time. Imaging is empowering scientists to distinguish neural systems associated with psychological procedures; comprehend infection pathways; perceive and analyze ailments early, when they have most successfully treated; and decide how treatments work.

IV. PROPOSED METHOD

There are different procedures accessible for denoising the restorative imaging by utilizing various image processing strategies. The proposed pre-processing structure used to denoising AD image dataset to upgrading the exactness of AD chance seriousness prediction. In this structure, to evacuate the noise in the image, the different methods are combined. Figure 1 represents the suggested pre-processing structure.

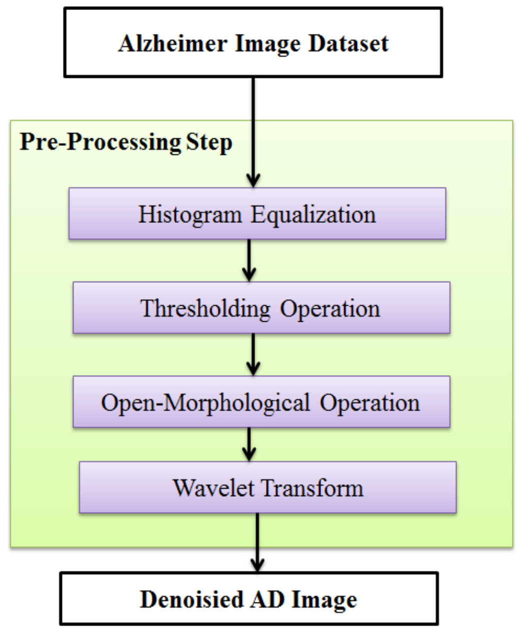

Fig. 1 Proposed Pre-Processing Framework for Denoising of Alzheimer Disease Image Dataset

Pseudo-code for the Proposed Pre-processing system for Denoising of Alzheimer Disease:

Stage 1: Image is contribution to the suggested pre-processing system. An image is resized-into 256 × 256 and changed over into a grayscale image.

Stage 2: Histogram Equalization is connected to enhance the image quality.

Stage 3: Image thresholding has beenperformed. The pixels esteems have named as zero and other is one using limit.

$G(x,y) = 1 \; f(x,y) \geq T$
$0 \; f(x,y) \leq T$

Stage 4: It is helpful for centering locales and furthermore stacks holes in an image. Open Morphology has utilized in the proposed pre-processing structure to decrease the little openings that make noise.

Stage 5: Wavelet transform approach has used to reject the noise in AD image set.

V. RESULTS AND DISCUSSION

The Alzheimer Image dataset from different sources like OASIS, Kaggle has been used for experiments. The performance of proposed combination of methods for Alzheimer disease image data has been evaluated against the most familiar mean and median filters. The input images are named as ADImage1, ADImage2, ADImage3…ADImageN.

A. Performance Metrics

The widely used quantitative measure peak signal-to-noise ratio (PSNR) and root mean squared error (RMSE) are used for evaluating the efficiency of proposed combination of methods for Alzheimer disease image.

1. Root Mean Squared Error (RMSE)

RMSE designates the collective squared error among original and restored image. Lower the value of MSE occurs in less error.

$$RMSE\left(f(x,y),\hat{f}(x,y)\right)^2 = \sqrt{\frac{1}{m*n}\sum_{y=1}^{n}\left(f(x,y),\hat{f}(x,y)\right)^2}$$

2. Peak Signal to Noise Ratio (PSNR)

PSNR is applied as quality measurement between $f(x,y)$, and $\hat{f}(x,y)$. Higher the PSNR effects in improved quality of image. The PSNR is computed by using the equation

$$PSNR\left(f(x,y),\hat{f}(x,y)\right) = 10 * \log_{10}\left(\frac{N^2}{RMSE}\right)^2$$

Where N symbolizes the number of grey levels, m and n symbolizes the dimension of an original image.

B. Discussion

Table I - Table VI portrays the execution examination of the proposed structure with too much known filters, Median and Mean filter for noise elimination in AD image dataset at various noise levels i.e. from 5% to 30%. The performance results of three AD images have been shown in the analysis report. Root Mean Squared Error esteem must be low, and Peak Signal to Noise Ratio esteem must be high for good quality image.

From the RMSE and PSNR values acquired for both proposed and existing methods, obviously the proposed combination of methods for pre-processing of Alzheimer image gives the significantly better outcome over the most often consumed median and mean filter techniques. Though the time complexity for the proposed strategy high then the existing methods used for comparative study, the proposed combination works fine for Alzheimer image dataset.

TABLE I PERFORMANCE OF PROPOSED WORK WITH OTHER TWO FILTERS FOR DENOISING OF AD IMAGE AT NOISE LEVEL OF 5%

Image Number	**Performance Metrics**	**Input Image at 5% Noise Level**		
		Median Filter	**Mean Filter**	**Proposed Framework**
ADImage1	RMSE	8.14	8.32	7.54
	PSNR	27.71	27.55	28.25
ADImage2	RMSE	10.61	10.8	9.98
	PSNR	26.51	26.31	26.95
ADImage3	RMSE	10.21	10.81	9.79
	PSNR	27.82	27.99	28.36

TABLE II PERFORMANCE OF PROPOSED WORK WITH OTHER TWO FILTERS FOR DENOISING OF AD IMAGE AT NOISE LEVEL OF 10%

Image Number	**Performance Metrics**	**Input Image at 10% Noise Level**		
		Median Filter	**Mean Filter**	**Proposed Framework**
ADImage1	RMSE	16.16	18.63	16.28
	PSNR	23.84	22.73	24.95
ADImage2	RMSE	19.16	20.65	19.21
	PSNR	22.48	21.83	22.46
ADImage3	RMSE	20.53	21.34	20.02
	PSNR	21.77	21.55	22.00

TABLE III PERFORMANCE OF PROPOSED WORK WITH OTHER TWO FILTERS FOR DENOISING OF AD IMAGE AT NOISE LEVEL OF 15%

Image Number	**Performance Metrics**	**Input Image at 15% Noise Level**		
		Median Filter	**Mean Filter**	**Proposed Framework**
ADImage1	RMSE	23.10	23.59	22.29
	PSNR	20.83	19.11	20.98
ADImage2	RMSE	27.40	28.07	26.66
	PSNR	19.11	18.18	19.86
ADImage3	RMSE	30.77	31.44	30.01
	PSNR	18.11	17.90	19.15

TABLE IV PERFORMANCE OF PROPOSED WORK WITH OTHER TWO FILTERS FOR DENOISING OF AD IMAGE AT NOISE LEVEL OF 20%

Image Number	**Performance Metrics**	**Input Image at 20% Noise Level**		
		Median Filter	**Mean Filter**	**Proposed Framework**
ADImage1	RMSE	32.50	34.12	31.89
	PSNR	17.19	18.68	19.90
ADImage2	RMSE	37.26	38.16	39.22
	PSNR	16.32	15.84	17.45
ADImage3	RMSE	43.18	44.15	42.84
	PSNR	17.42	17.15	19.06

TABLE V PERFORMANCE OF PROPOSED WORK WITH OTHER TWO FILTERS FOR DENOISING OF AD IMAGE AT NOISE LEVEL OF 25%

Image Number	**Performance Metrics**	**Input Image at 25% Noise Level**		
		Median Filter	**Mean Filter**	**Proposed Framework**
ADImage1	RMSE	43.36	47.25	42.10
	PSNR	14.81	14.00	15.35
ADImage2	RMSE	49.39	50.24	48.20
	PSNR	14.18	13.22	12.19
ADImage3	RMSE	50.68	53.47	49.02
	PSNR	14.51	13.85	13.01

TABLE VI PERFORMANCE OF PROPOSED WORK WITH OTHER TWO FILTERS FOR DENOISING OF AD IMAGE AT NOISE LEVEL OF 30%

Image Number	**Performance Metrics**	**Input Image at 30% Noise Level**		
		Median Filter	**Mean Filter**	**Proposed Framework**
ADImage1	RMSE	54.62	58.73	54.00
	PSNR	14.01	13.36	15.32
ADImage2	RMSE	58.12	56.67	55.00
	PSNR	13.23	12.19	14.23
ADImage3	RMSE	53.62	55.02	51.18
	PSNR	10.78	12.42	13.91

Figure 2, 3 and 4 depicts the graphical representation of performance of Median and Mean Filters and proposed work for Denoising of ADImage1, ADImage2, and ADImage3 at various noise levels (5%, 10%, 15%, 20%, 25% and 30%) against RMSE value.

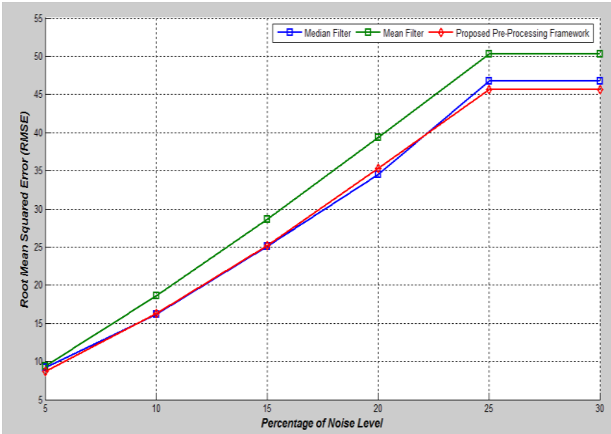

Fig. 2 Graphical representation of the ADImage1 performance analysis of Median Filter, Mean Filter and Proposed Pre-processing framework for Denoising of AD image dataset at various noise levels against the RMSE value

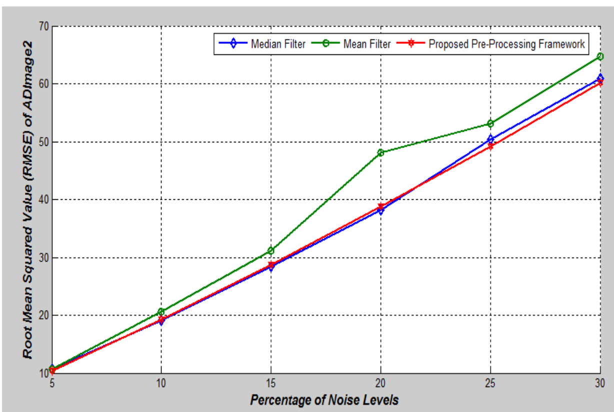

Fig. 3 Graphical representation of the ADImage2 performance analysis of Median Filter, Mean Filter and Proposed Pre-processing framework for Denoising of AD image dataset at various noise levels against the RMSE value

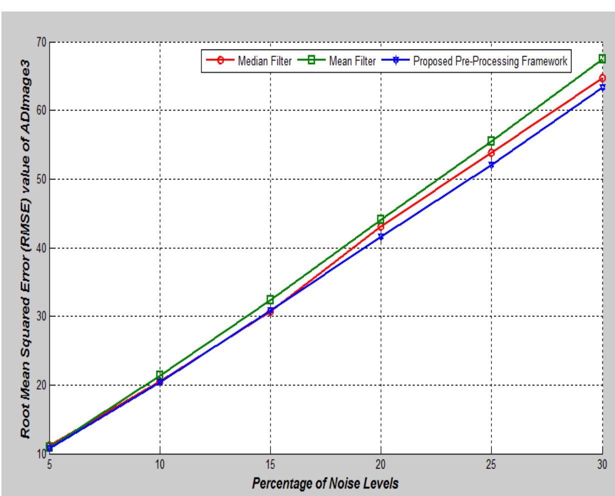

Fig. 4 Graphical representation of the ADImage3 performance analysis of Median Filter, Mean Filter and Proposed Pre-processing framework for Denoising of AD image dataset at various noise levels against the RMSE value

Figure 5, 6 and 7 depicts the graphical representation of performance of Median and Mean filter and proposed work for Denoising of ADImage1, ADImage2, and ADImage3 at various noise levels (5%, 10%, 15%, 20%, 25% and 30%) against PSNR value.

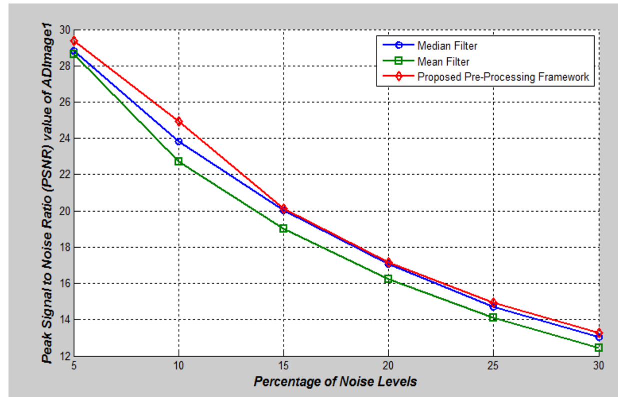

Fig. 5 Graphical representation of the ADImage1 performance of Median and Mean Filters and Proposed work for Denoising of AD image dataset at various noise levels against PSNR value

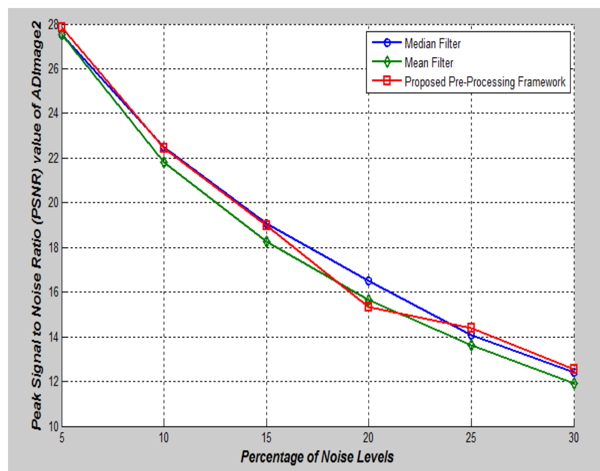

Fig. 6 Graphical representation of the ADImage2 performance of Median and, Mean Filter and Proposed work for Denoising of AD image dataset at various noise levels against PSNR value

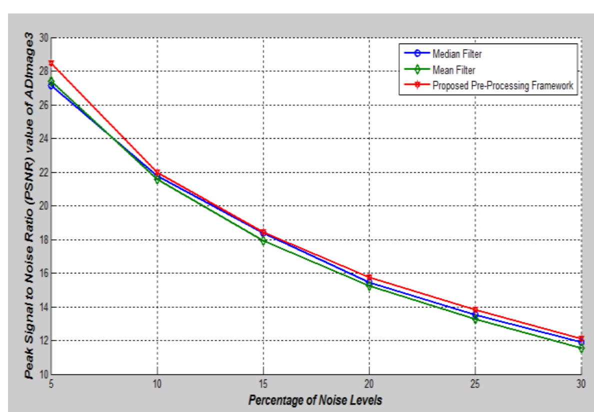

Fig. 7 Graphical representation of the ADImage3 performance of Median and Mean Filter and Proposed work for Denoising of AD image dataset at various noise levels against PSNR value

VI. CONCLUSION

In this paper, new pre-processing structure has been adopted for image denoising of Alzheimer Disease image dataset. The experimental outcomes demonstrate that the proposed structure suits well than the existing filtering strategies. The quantitative estimation of PSNR and RMSE demonstrates the feasibility of the employed combination of methods. The experimental results revealed that proposed structure can evacuate noise proficiently. Hence, the employed framework will be more helpful for physicians for diagnosing Alzheimer Disease more accurately.

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