COMPREHENSIVE ANALYSIS: NOISE AND TACKLING MECHANISMS FROM WITHIN MRI IMAGES

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ABSTRACT

Noise handling becomes need of the hour in the analysis of MRI images for detection of diseases in medical fields. There are number of imaging modalities used to analyse noise from within the MRI images. This paper presents a comprehensive analysis of techniques used to check presence of noise along with filtering mechanisms used to remove any noise from within the MRI images. In depth study of noises including salt and pepper and Gaussian is presented along with filtering mechanisms such as median , Gaussian and Gabor filters. Comparative analysis suggests the best possible mechanism for tackling noise within the MRI image.

Keywords: MRI images, Median Filter, Gaussian , Gabor Filter, Salt and pepper noise

Introduction

Magnetic Resonance Imaging (MRI) is a medical investigation of non invasive nature that utilizes magnetic fields and radio waves to see the inside structure of tissues and organs in the body. [1]discussed the segmentation of brain MRI images. Pre-processing mechanism included within the discussed literature include noise handling mechanism. The utilization of MRI as a diagnosing system keeps on developing and has turned out to be considerably quicker that it rivals the speed of Computed Tomography. The basic benefit of detecting diseases using MRI is that it doesn't make any harmful radiation to the patient. Amid clinical determination, the visual nature of the magnetic resonance images assumes an imperative part.[2] proposed fuzzy c means clustering mechanism for removing any abnormalities present within the MRI images. The MRI images are prone to the noise due to various sources like thermal effect, capturing device inability, inductive losses etc. In any case, amid acquisitions or transmissions these images are ruined with noise prompting deterrents in determination.

[3] proposed adaptive median filter for handling salt and pepper noise from within MRI images. MRI images are prone to noises which must be removed to present accurate diagnosis of disease if any within the MRI image. Along these lines de-noising should the essential step that should be taken before the image is analyzed. Image de-noising is trying, as expulsion of noise brings about noised and obscure images. For correct application of medical image processing the image should be de-noised so that it could facilitate accurate observation. [4] proposed a robust filtering mechanism for tackling noise from within the pattern recognition mechanism. This variation in noise may impact the adequacy of consequent examinations, conclusions, and treatments that depend on reliable anatomical information. Noise evacuation in MR images has been testing and basic in spite of huge advances in imaging strategies as recent years. It is of especially significance in modernized post processing systems, for example, tissue characterization, division, registration, and cerebrum mapping. There are various types of noises present within the MRI images these are as given below:

- Gaussian noise
- Salt and pepper noise
- Shot Noise
- Periodic Noise

Gaussian Noise: Gaussian noise is measurable in nature having a probability density function equivalent to that of the typical conveyance.[5]proposed a algorithm based on Gaussian Noise present within the MRI image. Gaussian noise is ordinarily an arrangement of qualities taken from a zero mean Gaussian appropriations which are added to every pixel. Incautious noise includes changing a piece of the pixel esteems with arbitrary ones. Gaussian noise expulsion calculations should smooth the unmistakable parts of the image. In image processing Gaussian noise can be lessened utilizing spatial filter. An uncommon instance of Gaussian noise is white Gaussian noise, in which the qualities are factually autonomous which depicts the relationship of noise. Gaussian noise is utilized as an added substance repetitive sound deliver added substance white Gaussian noise.

Salt and Pepper Noise

It is otherwise called impulse noise.[6] discussed details about the impulse or salt and pepper noise. Salt and pepper noise is a type of noise sometimes observed on images. Noise can be caused by sharp and sudden unsettling influence in image signal. It presents itself as meagrely happening white and dark pixels. A viable noise decrease calculation for this type of noise the median filter is used.

Shot Noise

Shot noise occurs on the darker region of the image due to fluctuations in the statistical quantization.[7]discussed the shot noise within the images occurring due to variation of light through light emitting diodes. Statistical quantization noise occurs when number of photons sensed varies at given exposure level. These variations happen due to leakage of current from the sensed mechanism capturing the image.

Periodic noise

This type of noise causes distortion within the images such as white dots appearing at most significant positions within the image.[8] presented noise model including periodic noise. Periodic noise occurs due to electrical and electromagnetic interference present within the image capturing source. This type of noise can be seen within the MRI images as spikes of distinct colours making MRI images difficult to analyse.

To tackle the noise present within the images denoising mechanisms such as filtering is required. De-noising refers to the demonstration of limiting the noise in a homogenous area without debasing the image elements. De-noising is normally utilized for post-processing strategies like reclamation, division, grouping, design investigation and others. Customarily, noise images need to experience the pre-processing venture before being subjected to advance analysis. The filtering calculation is the most widely recognized technique used to expel the noise, which is the pre-processing step. In medical imaging, the image filtering calculation procedure is utilized to improve the image quality and increment the deceivability, which help in the diagnostic procedure. There are various filter are used to de-noising the image which are as given below:

- Median Filter
- Gabor Filter
- Gaussian Filter

Median Filter

It is process that is non-linear and which is utilized as a part of limiting the careless or salt-and-pepper commotion.[9]presented a survey of various filtering with the stress on tackling salt and pepper noise. Median filter is a common choice in handling impulse or salt and pepper noise. It can likewise protect the edges in an image amid the way toward lessening irregular commotion. Amid the procedure an Impulsive or salt and pepper noise may happen because of an arbitrary piece mistake in the transmission channel. [10]In a median filter, a window is permitted to move along the image and the pixels with the median force esteem, over the window and turns into the yield power of the pixels that are prepared. This filter is regularly actualized to limit noise in an image, fairly like the mean filter. However, it for the most part completes a superior employment than the mean filter by saving valuable detail in the image. The filtering technique follows:

- Storing the neighboring pixels in an array
- Sorting the window in numerical order
- Selecting the median from the window as the pixel value

Median filter filters the impulsive and random noises. This filter is reputed to be edge preserving.

Gaussian Filter:

Gaussian filter is the strategy in which the peak reaction ends up being a Gaussian capacity. [11] discussed the removal of Gaussian noise from Dental MRI images. This filter does not give any speedy enhancement in detection process and consequently limits the ascent and fall time. This conduct is worried to the way that this filter will have the base conceivable delay. Scientifically, a Gaussian filtering technique alters the info motion by convolution to a Gaussian capacity; this change is known as the Weierstrass change. The way toward Smoothing is generally gone up against utilizing linear filters, for example, the Gaussian capacity, bringing about better outcomes creation and hence decreasing the impact of noise to that of the image.

Gabor Filter

The band pass filter suggested on an image processing so as to expel noises, break down the surface, and to assess stereo divergence. [12] discussed abnormal regions detection from MRI images by the application of Gabor filter. The drive response of these filters is a resultant of the result of a Gaussian envelope function. Through Gabor filtering process, we could see that the essential capacity diminishes the space (time)-vagueness item. By conveying these capacities to 2D it turns out to be anything but difficult to create filters for introduction. At particular conditions, the stage reaction of this filter is near linearity. This misused factor is because of the stereo methodology that uses the stage distinction of the reaction of both left and right filter keeping in mind the end goal to adjust the disparity in the stereo images.

This paper surveys the various techniques to remove noise from the image and also the methods to restore the image. It also describes the various sources of noise and application of various image restoration techniques. Rest of the paper is organised as under: section 2 presents the literature survey of hybrid mechanisms used to tackle noise from the image. section 3 presents the comparison of filtering mechanisms used to tackle noise, section 4 gives the conclusion and last section gives references.

Literature Survey

This section provides the background analysis of hybrid techniques used to eliminate noise from the images. Noise is introduced due to variation of brightness at distinct intervals within the image. tackling noise occurring due to multiple variations is difficult to analyse and remove by the use of simple filter hence hybridization of filtering mechanisms is required.

[13] The current framework accessible for fuzzy filters to perform noise reduction and manages fat-tailed noise like impulsive noise and median filter. Just impulsive noise decrease utilizes fuzzy filters. Gaussian noise isn't extraordinarily focused; it doesn't recognize nearby variety because of noise and because of picture structure. The proposed framework exhibits another procedure for filtering narrow tailed and medium filter noise by a fuzzy channel. The framework first gauges a "fuzzy derivative" keeping in minds the end goal to be less delicate to nearby varieties because of picture structures, for example, edges. Second, the membership functions are adjusted as needs be to the noise Level to perform "fuzzy smoothing." another fuzzy channel is exhibited for the noise diminishment of pictures defiled with added substance noise. The channel comprises of two phases. The primary stage processes a fuzzy derivative for eight distinct headings. The second stage utilizes these fuzzy derivatives to perform fuzzy smoothing by weighting the commitments of neighbouring pixel esteems. The two phases depend on fuzzy derivatives which make utilization of enrolment capacities. The channel can be connected iteratively and adequately diminish overwhelming noise. Specifically, the state of the participation capacities is adjusted by the rest of the noise level after every emphasis, making utilization of the dissemination of the homogeneity in the picture. A measurable model for the noise appropriation can be joined to relate the homogeneity to the adjustment plan of the enrolment capacities. Experiments are done to obtain feasibility of the proposed approach. These outcomes are likewise contrasted with different filters by numerical measures and visual review.

[14]The noise reduction of corrupted images can be resolved using fuzzy filters. This filter consists of two stages. The first stage computes fuzzy derivatives and second stage perform fuzzy smoothening by weighting the neighbouring pixels. These stages are based on fuzzy rules and uses membership function. This filter performs iteratively to reduce noise from the images. After each iteration the noise level is achieved from membership function. A statistical model is developed for noise distribution can be incorporated to relate homogeneity in the images. The proposed approach obtained the experimental results and compares the results by using numerical values.

[15]image restoration is a better approach to process the image using different filtering methods. The noisy image can be enhanced by reconstructing into original form by removing the noise from image. For image restoration there are number of algorithms having some pros and cons. The number of techniques is used on the basis of non linear filter to restore image. As compared to other filters like, Weighted Fuzzy Mean (WFM) filter, Minimum-maximum Detector Based (MDB) filter, Adaptive Fuzzy Mean (AFMF) filter, Centre Weighted Mean (CWM) filter, and Min-max Exclusive Mean(MMEM) filter on the basis of (Peak Signal to Noise Ration) PSNR the performance of Histogram Adaptive Fuzzy (HAF) filter is carefully examined and compared with other filters to obtain better results. Experimental results on images show the capabilities of all the studied approaches and provide optimal results.

. [16] Noise degrades the quality of the image. In case of images captured through the satellite, medical images etc., is becomes a challenging task for the researchers in digital image processing. For noise reduction number

of approaches is present. Synthetic Aperture Radar (SAR) satellite images and medical images always contain speckle noise. In this research paper some of the filtering techniques for the removal of speckle noise from the satellite images are given, which enhances the quality of the images. Although for speckle reduction, some filters are best suited for SAR images and are used for the statistical parameters are calculated for the output images obtained from all the filters. The statistical measures SNR, PSNR, RMSE and CoC are compared to obtain the results. The output images which performs the best statistical values are displayed along with the filters name and corresponding values of the statistical measures are also given.

Next section provides comparison of hybrid techniques used to tackle noise from within the image discussed in literature survey.

Comparison Table

Reference	Technique Used	Parameter	Merits	Demerits
[13]	Fuzzy Filter, Contrast Enhancement	Fat tailed noise like median filter and impulse noise	Effectively reduce high noise	Not properly solve the problem of noise
[14]	Fuzzy Filter	MSE, fuzzy smoothening, fuzzy derivative	Remove impulse noise	Difficult to remove impulse noise densities
[15]	Histogram Adaptive Fuzzy Filter	WFM, MDB, CWM, AFMF, PSNR	Enhance digital image noise	Recovery of image signal is not possible
[16]	Speckle noise, K Frost filter	SNR, PSNR, RMSE	Enhance image quality and reduce noise variance	Only remove speckle noise from satellite images
[17]	Hybrid Filtering Technique	MSE, PSNR, IEF	Remove impulsive noise	Not provide good performance in sense of noise
[6]	Median filter	PSNR, MSE	Noise reduction in colour images	Cannot handle the corrupted images that are complex
[8]	Mean Filter, Median Filter	SNR, PSNR	Remove noise of image and image restoration	Loses details of the images

Table 1: Comparison of hybrid filtering mechanisms used to tackle noise from the MRI images

Conclusion and Future Scope

This paper presents the comparative analysis of noise and filtering mechanisms that are critical to record any diseases present within the MRI images. Clarity within MRI images is compulsory in order to accurately distinguish the normal image from the corrupted one. Various noises present within the images are studied in depth. The survey suggests salt and pepper noise is most common among the MRI images and Gaussian noise

is most difficult to tackle. To tackle noises filtering mechanisms are discussed. In case of complex images noise, hybridization is mandatory. Comparative analysis suggests PSNR and MSE are the parameters to optimize in future.

In future, enhancement of adaptive median filter to tackle noises such as salt and pepper, Gaussian and shot noise can be proposed.

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