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A Proposed Framework to De-noise Medical Images Based on Convolution Neural Network

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Abstract: ***These days analysing patient data in the form of medical images to perform diagnose while doing detection and prediction of a disease has emerged as a biggest research challenge. All these medical images can be in the form of X-RAY, CT scan, MRI, PET and SPECT. These images carry minute information about heart, brain, nerves etc within themselves. It may happen that these images get corrupted due to noise while capturing them. This makes the complete image interpretation process very difficult and inaccurate. It has been found that the accuracy rate of existing method is very less so improvement is required to make them more accurate. This paper proposes a Machine Learning Model based on Convolutional Neural Network (CNN) that will contain all the filters required to de-noise MRI or USI Images. This model will have same error rate efficiency like those of data mining techniques which radiologists were interested in. The filters used in the proposed work are namely Weiner Filter, Gaussian Filter, Median Filter that are capable of removing most common noises such as Salt and Pepper, Poisson, Speckle, Blurred, Gaussian existing in MRI images in Grey Scale and RGB Scale.***

Keywords: Convolution Neural Network, Denoising, Machine Learning, Deep Learning, Image Noise, Filters

1. INTRODUCTION

The term de-noising means the elimination of unwanted noises existing in the medical images so that the disease can be predicted more accurately. Image De-noising is one of the most important techniques in the field of image processing. In most of the real-life medical images different types of noise distortions occurs as a challenge in image de-noising. Improved medical images are used by doctors and surgeons to help diagnosing a disease in better and accurate way. The noise present in the images can appear as an add-on component and the main purpose of denoising is to remove these unrefined modules. Image re-construction is an alternative term used to eliminate these noise components while incorporating most possible features. For the same purpose, the concept of wavelet thresholding has been adopted for signal de-noising from centuries. This is because the wavelet provides a suitable basis for removing a noisy component from the image signal. By incorporating wavelet transform we can do compression and de-noising. This entire process includes three phases namely i) Performing thresholding ii) Wavelet selection and c) Evaluating PSNR of each wavelet. These days radiologists are showing their keen interest in medical data mining. Different applications of Medical Image de-noising are (a)Pre-processing of Lung Images for improving the picture quality, (b) De-noising techniques for medical ultrasound and for magnetic resonance images, (c) Practical applications will often simplify the theory using heuristics which gives lower complexity and higher flexibility. Due to these requirements, Machine Learning algorithms are increasingly gaining success in image-based diagnosis, disease detection and disease prognosis.

2. RESEARCH OBJECTIVES

The basic objective of de-noising is to improve the perceived quality of images. Feature is a fundamental element for ultrasonic image classification. Feature extraction approaches evaluate the pre-processed images in order to

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extract the most essential features which represent different sets of features based on the pixel intensity relationship statistics. Optimization techniques like particle swarm optimization, firefly optimization etc. have not been suggested to minimize the noise level. Hence, research on statistical approaches is a biggest challenge in machine learning technique. Table 2.1 represents the Comparative Analysis of Different De-noising Techniques based on Different Quality Measures.

TABLE 2.1 Comparative Analysis of Different De-noising Techniques based on Different Quality Measures

		PSNR	SNR	MSE	NAE	Correlation	SSIM
NOISY IMAGE	WAVELETS	38.2826	9.1978	9.6564	0.2254	0.9446	0.8882
	PCA	38.3214	9.1727	9.5706	0.2248	0.9444	0.8849
	PCA_NLM	**38.3270**	**9.1783**	**9.5582**	**0.2249**	**0.9445**	**0.8847**
DENOISY IMAGE	WAVELETS	39.8420	10.7617	6.7435	0.1856	0.9571	0.9265
	PCA	42.4252	13.2764	3.7202	0.1489	0.9765	0.9472
	PCA_NLM	**42.6466**	**13.4979**	**3.5352**	**0.1385**	**0.9778**	**0.9567**

3. LITERATURE SURVEY

In [1] a multi view image de-nosing approach named MVCNN using CNN has been proposed. The MVCNN is trained to produce a denoised image stack that contains the recovered image information. The denoised stacks are then merged together to generate a denoised target view image. This CNN-based algorithm saves time wasted in exhaustive patch searching and also minimizes the computational time. In [2] author suggested a deep learning method-based approach to denoise medical images. This paper provides a gentle introduction to deep learning in medical images. proceeding from theoretical foundations to applications. This work discusses some promising approaches that can help resolving the inaccuracy challenges found in medical images through a deep learning approach. Author in [3] highlights the concept of deep learning and indicates how deep learning can be applied to the entire MRI chain, from image acquiring to its retrieval and from image segmentation to disease diagnosis. The paper [4] discusses denoising of multi-view images with both intra-view and inter-view duplicity exploited using 3-D geometry constraints. The suggested model is first adopted in image denoising and outperforms the existing de-noising methods on the multi-view image sequence. Furthermore, the proposed method is more consistent and complete compared with those reconstructed from denoised images by other methods. In [5]-[8] author discusses different image de noising techniques and their advantages.

4. BACKGROUND STUDY

Image denoising is very essential and fundamental step in analysis of medical images ([5]-[8]). This paper exhibits the current challenges and the existing techniques related to medical image denoising. It happens due to

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different factors which include many external causes in the transmission system and environmental factors. The different types of noises that can be found in medical images namely A. Gaussian Noise B. Salt and Pepper Noise C. Blurred Noise D. Speckle Noise E. Poisson .

Types of Noise in Medical Images: Noise are explained briefly as below:

a) Gaussian Noise

The Gaussian noise has a probability density equation of the normal distribution. It is added to MR image during image acquisition such as sensor noise caused by low light, high temperature, transmission. The Probabilities Density Function (PDF) of Gaussian Noise is shown in the following equation where P(x) is the Gaussian distribution equation noise in MR image; μ and σ is the mean and standard deviation respectively.

b) Salt and Pepper Noise

This noise occurs due to the presence of bright and dark pixel elements. Due to sharp and unexpected changes of images arise, abrupt changes, or dead pixels. It can be removed using DFS (Dark Frame Subtraction). It is also termed as impulse noise.

c) Blurred Noise

This type of noise leads to dizziness or blurriness in the image. This noise occurs due to the reason capturing reasonable photos under low light visions using a hand-held camera.

d) Speckle Noise

This noise occurs due to error in data transmission. These are the granular noises present in the images. It reduces the quality of the aperture radar, and Synthetic Aperture Radar (SAR) or Magnetic Resonance Imaging (MRI).

e) Poisson Noise

It is an electronic noise which is a form of ambiguity related to the quantity of the light. This noise results in reducing the clarity of the medical images.

Types of Filters Utilized in de-noising Medical Images

Several filters to de-noise images that are commonly adopted are: A. Median Filter. B. Weiner Filter. C. Gaussian Filter. The need for smoothening of images becomes essential, which is required to remove the noise and filter the medical image. All these filters are explained below:

a) Median Filter

It is known as order-static filtering in image processing. Median Filter is a prevalent technique because it takes the particular area and calculates the intensity of all the pixels in the median filter. A median filter replaces the pixel with the median of the neighbourhood. This is useful in removing noise from a single image. The median filter does this by removing large noise spikes from the image.

b) Weiner Filter

This filter deals with the corrupted noise signal and filters the image pixel by pixel. If anyone wants to use the Weiner filter, then he/she/ others may know about the properties of the image. It removes the blurred and other types of noise present in it. There is a property called a mean square error calculated for every image. It reduces the mean squared error value to a more excellent range.

c) Gaussian Filter

This filter is used to specially remove speckle noise present in ultrasound images or MRI brain images. Gaussian Distribution works in it. The noise pixel, which is present in the image, is replaced by the average of the surrounding pixel. Such that the noise pixel takes the average intensity values. This paper classifies the de-noising

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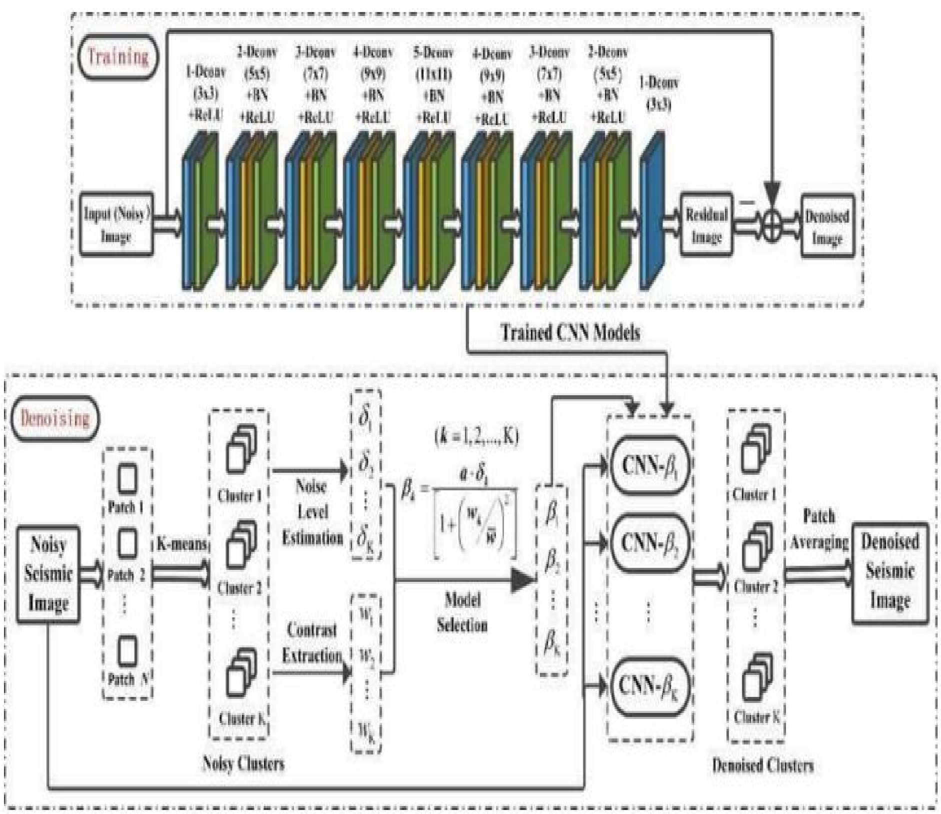
process of different types of images such as Radiography, Ultrasonography, Computed Tomography, Medical Resonance Imaging.

5. PROPOSED METHODOLOGY

Image quality is the quality of a picture that relies solely on the resolution and density. This paper works on designing a machine learning model based on CNN to denoise MRI images. This framework will have same error rate efficiency as of other data mining approaches. The Machine learning model will contain different denoising algorithms altogether. The proposed work performs better as we utilize CNN since the traditional approaches cost higher whereas but the proposed model proves to be very cost effective on long run.

5.1 Software and Package Requirements

The proposed work can be implemented by making use of few software and packages. Different software requirement are MATLAB tool, Python, Tensor Flow, Anaconda Navigator and Jupyter Notebook and TFR Record. Similarly, Packages Requirements are Numpy, PIL/PILLOW (Python Imaging Library), OpenCV , SimpleCV, ipyKernel and SymPy.



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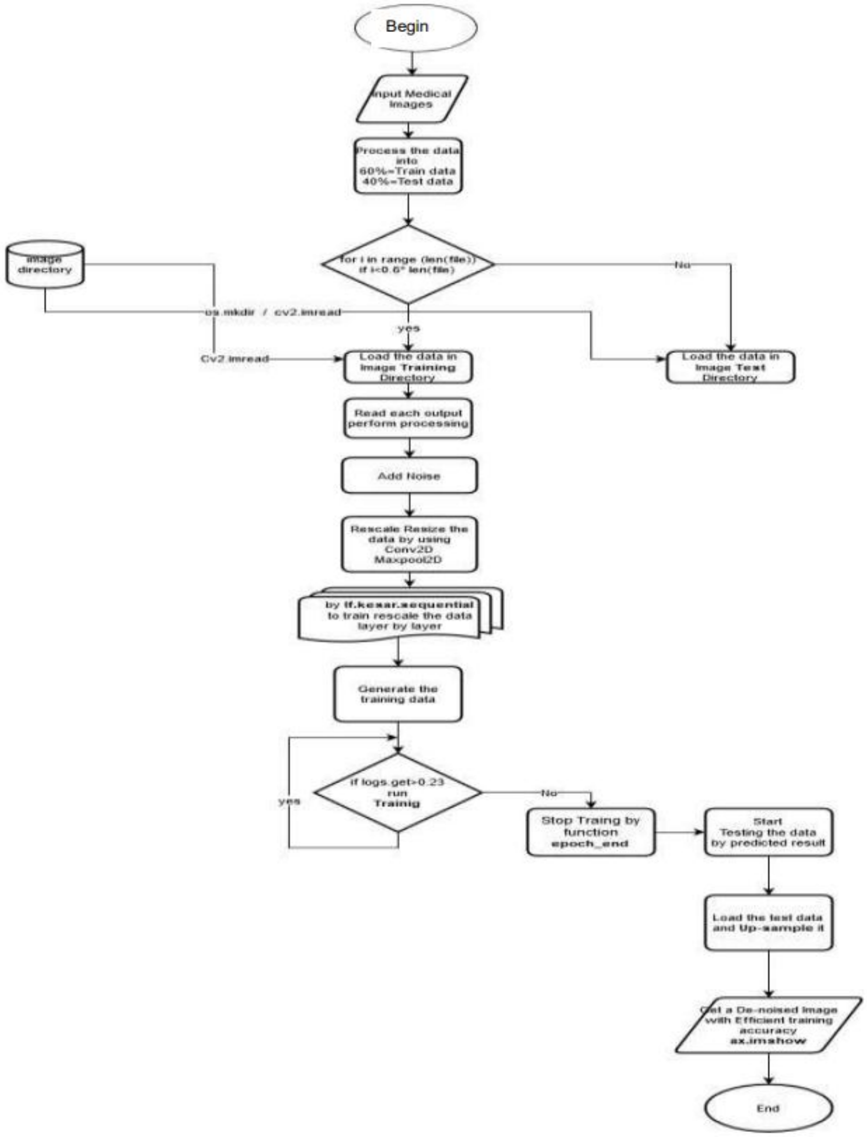

6. CONCLUSION

This paper focuses on different methods of image de-noising in nonlinear domain It has been observed that the linear methods are comparatively simple, effective and easy to implement but they are limited with high noise factors. Nonlinear methods work differently from each other depending on the type of noise present. Several types of noise like impulse, Gaussian white noise and speckle are considered through associated de-noising techniques. From the proposed work it is found that the wavelet domain achieves great performance due to their noise adaptive and sparseness strength. Median based methods have been outstanding for image restoration because of nonlinearity but comparatively spatial domain computations are complex and time consuming.

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