Enhanced Image De-Noising using Low Rank Matrix Decomposition and Support Vector Machine

Tanvi Gupta[#1], Chandandeep Sandhu[*2]
Chandigarh University, Gharuan
[*]Assistant Professor
Chandigarh University, Gharuan

Abstract: ***Image Denoising is one of the most challenging research area in image processing, because image denoising techniques not only poised some technical difficulties, but also may result in the destruction of the image (i.e. making it blur) if not effectively and adequately applied to image. An image enhancement method is proposed by using low rank matrix decomposition and support vector machine. In order to enhance the image, LRMD i.e. Low rank matrix decomposition is applied on image to remove the noises. It describes the problem of finding and exploiting low-dimensional structures in high-dimensional data. The aim of Low Rank Matrix approximation based image enhancement is that it removes the various types of noises in the contaminated image simultaneously. The main contribution is to explore the image denoising low-rank property and the applications of LRMD for enhanced image Denoising, Then support vector machine is applied over the result. This study exhibits a video which is converted into different sizes of frames so that it can be enhanced easily. Then noisy image and enhanced image are compared to obtain higher signal to noise ratio and other parameters like Peak Signal to Noise Ratio, structural similarity index, Mean Square Error for qualitative assessment to the enhancement result.***

Keywords: ***De-noising, Low Rank Matrix Decomposition (LRMD) and Support Vector Machine (SVM)***

1. INTRODUCTION

Image processing is a type of sign handling for which the info is an image. For example, a photo or feature edge and the yield of image transforming may be either an image or the image parameters. Image is a two dimensional capacity of two genuine variables. Image= f(x, y) where, x and y are the spatial directions known as pixels and f is the abundance. In the recent past, transforming an image is changed over into the advanced structure. The digitization incorporates; inspecting of images and quantization of the examined qualities. In this way in the wake of changing over the image into bit data the preparing is performed. The processing method may be image upgrade; image reproduction and image pressure.

1.1 Medical Image De-noising

The arrival of digital medical imaging technologies such as positron emission tomography (PET), magnetic resonance imaging (MRI), computerized tomography (CT) and ultrasound Imaging has revolutionized modern medicine. Today, many patients no longer need to go through invasive and often dangerous procedures to diagnose a wide variety of illnesses. With the widespread use of digital imaging in medicine today, the quality of digital medical images becomes an important issue. To achieve the best possible diagnosis it is important that medical images be sharp, clear, and free of noise and artifacts. While the technologies for acquiring digital medical images continue to improve, resulting in images of higher and higher resolution and quality, removing noise in these digital images remains one of the major challenges in the study of medical imaging, because they could mask and blur important subtle features in the images, many proposed de-noising techniques have their own problems. Image de-noising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images.

Noise modelling in medical images is greatly affected by capturing instruments, data transmission media, image quantization and discrete sources of radiation. Different algorithms are used depending on the noise model. Most of images are assumed to have additive random noise which is modelled as a white Gaussian noise. Medical images such as magnetic resonance imaging (MRI) and ultrasound images have been widely exploited for more truthful pathological changes as well as diagnosis.

However, they suffer from a number of shortcomings and these includes: acquisition noise from the equipment, ambient noise from the environment, the presence of background tissue,

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other organs and anatomical influences such as body fat, and breathing motion. Therefore, noise reduction is very important, as various types of noise generated limits the effectiveness of medical image diagnosis.

2. RELATED WORK

Lin Xu, Changqing Wang, Wufan Chen, and Xiaoyun Liu, IEEE 2014

In this paper, Parallel magnetic resonance imaging methods can speed up MRI look over a multi-channel loop exhibit accepting signal at the same time. The noise amplification and aliasing artifacts are not kidding in pMRI recreated images at high expanding speeds. This study displays a patch-wise denoising technique for pMRI by abusing the rank lack of multi-channel coil images and sparsity of antiques. For each prepared patch comparable patches an explored in spatial area and all through all coil components and masterminded in suitable grid structure. At that point noise and aliasing artifacts are expelled from the organized grid by applying scanty and low rank matrix decomposition system. The proposed technique has been approved utilizing both phantom and in vivo brain data sets and delivering empowering results. The system can viably evacuate both noise and residual aliasing artifact from pMRI recreated loud pictures and produce higher peak signal noise rate (PSNR) and structural similarity index matrix (SSIM) than other best in class denoising strategies.

Abha Choubey, Dr. G.R.Sinha, Siddhartha Choubey, IEEE 2011

In this paper the picture preparing accepts a vital part in the medicinal field in light of the fact that a large portion of the maladies are analyzed by method for restorative pictures. To utilize these pictures for the diagnosing system and it must be a quiet one. Regardless most of the pictures are influenced through commotions and relics brought about by the different securing strategies and henceforth an Effective strategy for denoising is fundamental for restorative pictures especially in Computed Tomography which is a huge and most broad methodology in medicinal imaging. To accomplish this denoising of CT pictures a compelling CT picture denoising strategy is proposed. The proposed work is included three stages are Pre-processing and preparing and testing. The CT picture which is influenced by the AWGN commotion is changed utilizing multi wavelet change as a part of the pre-processing stage. The acquired multi-wavelet coefficients are given as info to the Adaptive Neuro-Fuzzy Inference System (ANFIS) in the preparation stage. The data CT picture is inspected utilizing this prepared ANFIS and after that to upgrade the nature of the CT picture thresholding is connected and afterward the picture is recreated in the testing stage. Henceforth the denoised and the quality improved CT pictures are acquired in a successful way.

3. TECHNIQUES USED

There are three main techniques are used to enhance the results of this thesis. These techniques are discussed below:

2.1 Low-Rank Matrix Decomposition

LRMR is derived from compressed sensing theory has been successfully applied various matrix completion issues for example image compression video denoising and dynamic MRI Compared with classical denoising methods. Denoising techniques based on low rank completion enforce fewer external assumptions on noise distribution. These methods rely on the self-similarity of three dimensions (3-D) images across different slices or frames to construct a low rank matrix. The significantly varying contents between different slices or frames may lead an exception to the assumption of low-rank 3-D images and discount the effectiveness of these methods. This paper propose to remove both noise and aliasing artifacts in pMRI image by using a sparse and low rank decomposition technique. By exploiting the self-similarity between multi-channel coil images and inside themselves we formulated the denoising of pMRI image as a non-smooth convex optimization problem that minimizes a combination of nuclear norm and L1norm. The proposed issue is efficiently solved by utilizing the alternating direction method of multipliers (ADMM). Experimental results of phantom and in vivo brain imaging are given to demonstrate the performance of the proposed method with comparisons to the related denoising techniques.

2.2 Support Vector Machine (SVM)

It is primarily a classifier in which Width of the margin between the classes is the optimization criterion, i.e. empty area around the decision boundary defined by the distance to the nearest training patterns. These are called support vectors. The support vectors change the prototypes with the main difference between SVM and traditional template matching techniques is that they characterize the classes by a choice limit. This decision boundary is not just defined by the minimum distance function. The concept of (SVM) Support Vector Machine was introduced by Vapnik. The objective of any machine that is capable of learning is to achieve good generalization performance, given a finite amount of training data. The support vector machines have proved to achieve good generalization performance with no prior knowledge of the data. The principle of an SVM is to map the input data onto a higher dimensional feature space nonlinearly related to the input space and determine a separating hyper plane

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with maximum margin between the two classes in the feature space. The SVM is a maximal margin hyper plane in feature space built by using a kernel function. This results in a nonlinear boundary in the data space. The optimal separating hyper plane can be determined without any computations in the higher dimensional feature space by using kernel functions in the input space. There are some commonly used kernels include:-

a) Linear Kernel
K(x, y) = x, y
b) Polynomial Kernel
K(x, y) = (x. y+1) d

SVM Algorithm

- **i.** Define an optimal hyper plane.
- **ii.** Extend the above definition for non linear separable problems.
- **iii.** Map data to high dimensional space where it is easier to classify with linear decision surfaces.

4. PROPOSED WORK

The block diagram of the proposed work is shown in the following Figure1.

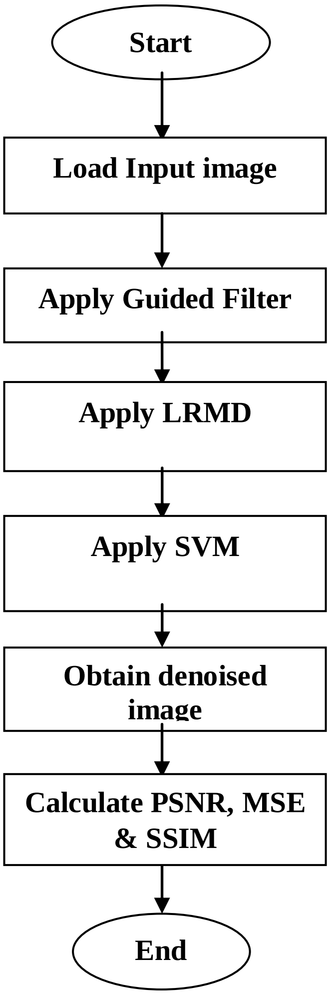

Figure 1: Flowchart of proposed work

This diagram has some important phases of proposed work that are discussed in the following points:

Phase 1:
First an opening GUI for this implementation is developed. After that a code for the loading the images in the Matlab database is developed.

Phase 2:
Start a process and load a medical image as input in database file in the MATLAB.

Phase 3:
Develop a code to obtain denoised images and apply filters. Then we got denoised images.

Phase 4:
After that code for the LRMD and SVM Algorithm is developed. With the help of LRMD and SVM analysis of proposed algorithm is done. Also MSE, PSNR and SSIM values are calculated and plotted.

5. PARAMETERS USED

Following are the two main parameters that are used to calculate the results of the proposed work in this thesis. These parameters are:

5.1 Peak Signal to Noise Ratio (PSNR):

PSNR is the ratio value between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

The PSNR of the fusion result is defined as follows:

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$$\text{PSNR}= 10\text{X}\log\left(\frac{(f_{\max})^2}{MSE^2}\right)$$

Where fmax is the maximum gray scale value of the pixels in the fused image. Higher the value of the PSNR is better the performance of the fusion algorithm.

5.2 Mean Square Error (MSE):

A commonly utilized reference based assessment metric is the Mean Square Error (MSE). The MSE between a reference image R and a fused image F is given by the
Following equation:

$$\text{MSE} = \frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\left(R(m,n) - F(m,n)\right)^2$$

Where R (m, n) and F (m, n) are the reference and fused images respectively and M and N are image dimensions. Smaller the value of the RMSE is better the performance of the fusion algorithm.

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5.3 Structure Similarity Index

This parameter is employed for measure the similarity between 2 pictures. It's enforced to recover on ancient ways like peak S/N (PSNR) and mean square error (MSE).The distinction with reference to different parameters like MSE or PSNR is that it estimates perceived

$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

6. RESULTS AND DISCUSSION

In the following figures, result of proposed algorithm is highlighted.

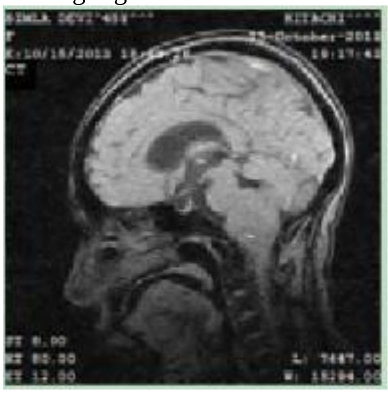

Figure 2: Original image

Figure 2: Noisy image

Figure 3: Denoised image after LRMD

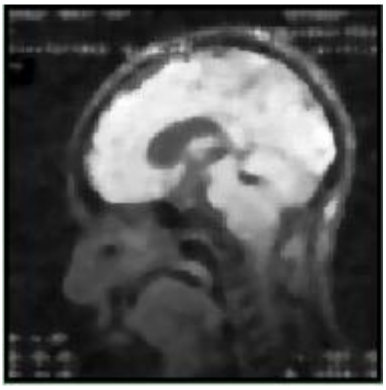

Figure 4: Denoised image after SVM

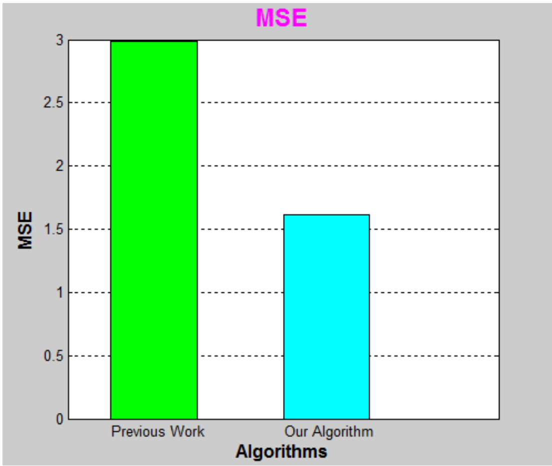

Figure 5: MSE of previous and proposed work

Comparison of MSE between Previous and our algorithm

	Previous Work	Proposed Work
MSE	2.9890	1.6165

Figure 6: Values of MSE

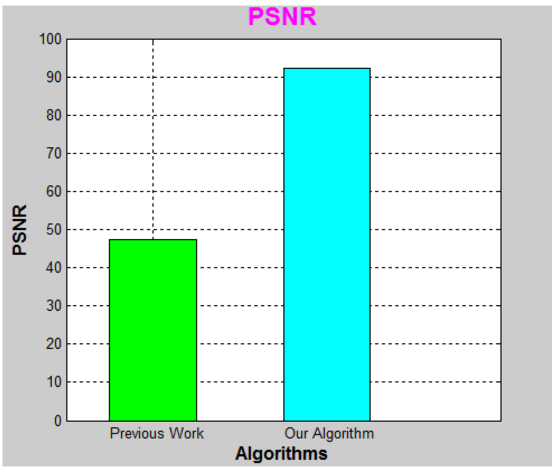

Figure 7: PSNR of previous and proposed work

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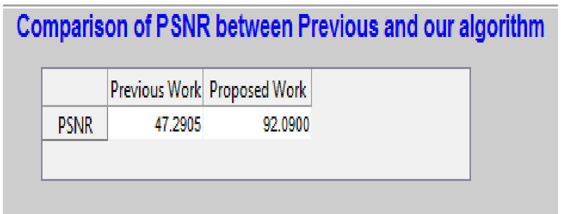

Comparison of PSNR between Previous and our algorithm

	Previous Work	Proposed Work
PSNR	47.2905	92.0900

Figure 8: Values of PSNR

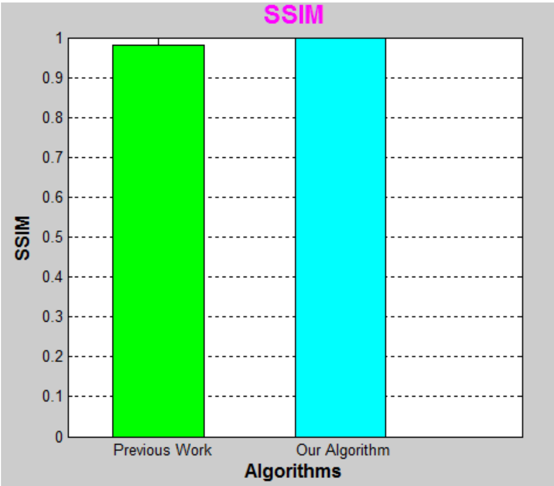
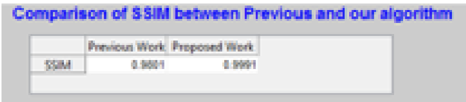


Figure 9: SSIM of previous and proposed work


Comparison of SSIM between Previous and our algorithm

	Previous Work	Proposed Work
SSIM	0.9801	0.9991

Figure 10: Values of SSIM

7. CONCLUSION

From the above précised discussion, it will be valuable observation into several concepts elaborated, and raise further advances in the area. The exact enhancement is directly built upon the nature of the material to be read and by its factors. Present research is directly concern to the Medical images. From different studies, we have seen that the selection of Low Rank Matrix Decomposition (LRMD) technique plays an important role in performance of Enhanced image denoising. This review establishes a complete system that improves the quality of enhanced image. After that the medical images are enhanced by using the proposed techniques i.e. low rank matrix decomposition (LRMD) and support vector machine (SVM). This material serves as a guide and update for readers working in the enhanced area. Future work may be further applied new formulas or algorithm for the enhancement of denoised images. The proposed algorithm can be implemented on different tools.

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