A Hybrid Approach for Smoothening and Denoising of an Image Using Enhanced Oversampling Algorithm

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Abstract: ***In imaging science, image processing is any form of signal processing for which the image or video frame is an input, the output of image processing may be either an image or a set of characteristics or parameters related to the image. Phase retrieval of oversampled diffraction patterns is fundamentally limited by investigational noise. It remains a challenge to perform steady phase retrieval of weakly scattering objects such as biological specimens from noisy experimental data. When a coherent wave illuminates a noncrystalline specimen, the diffraction intensities in the far field are continuous and can be sampled at a frequency finer than the Nyquist interval (i.e. oversampled).Existing methodology works on iterative approach for phase retrieval of linearly distributed noisy image also the system does not have any image enhancement after reconstruction. This system works for phase retrieval of linearly/non linearly distributed noisy diffracted images, also this system provides image enhancement of the reconstructed image by using three different filters i.e. Inverse filter, Wiener filter and Lucy Richardson filter and the best reconstruction is compared by MSE and PSNR values of the resulting image. After simulating so many images for both linearly distributed noisy image and non linearly distributed noisy image we conclude that Inverse filter is giving better reconstructions.***

Keywords: OSS (oversampling smoothness), HIO, Filters (Inverse Filter, Weiner filter, Lucy Richardson filter.)

1. Introduction

Image processing can be largely defined as the exploitation of signals which are essentially multidimensional. The most common signals are snapshots and video sequences. The goal of processing can be (i) compression for storage or communication (ii) improvement or restoration (iii) analysis, recognition, and understanding or (iv) visualization for human observers. The utilization of image processing methodology has become almost omnipresent they find relevance in such diverse areas as archaeology, medicine, astronomy, video communication, and electronic games. Nevertheless, many significant problems in image processing remain unclear. Some of the major domains of the image processing are, Image sharpening and restoration, Medical field, Remote sensing, Transmission & encoding, Machine/Robot vision, Color processing, Pattern recognition, Video processing, Microscopic Imaging, etc. In signal processing, oversampling is the method of sampling a signal with a sampling frequency considerably higher than the Nyquist rate. According to theory a bandwidth-limited signal can be completely reconstructed if sampled higher than the nyquist criteria, which is twice the highest frequency in the signal. Here an efficient iterative algorithm, oversampling smoothness (OSS), for phase retrieval of noisy diffraction intensities is presented [1]. OSS exploits the association information among the pixels or voxels in the region exterior of the support in real space. By accurately applying spatial frequency filters to the pixels or voxels outside the support at different stages of the iterative process (i.e. a smoothness constraint).In signal processing, a filter is a tool or process that removes from a signal some unnecessary feature. Filtering is a class of signal processing, the significant feature of filters being the complete or partial suppression of some aspect of the signal [12]. Most often, this means eliminating some frequencies and not others in order to restrain interfering signals and reduce backdrop noise. However, filters do not completely act in the frequency domain especially in the field of image processing many other targets for filtering exist [15]. Association can be removed for certain frequency components and not for others without having to act in the frequency domain. Various phase retrieval algorithms has been developed in the past but there is no image enhancement after retrieval like HIO, ER-HIO, NR-HIO, Oss finds balance between HIO and provide better reconstruction then the previously developed algorithms. Phase of any signal can be retrieved by the diffraction pattern of the image through iterative process but due to experimental noise the true phase cannot be achieved so the reconstruction of the image exactly as the input image remains a challenge.

In the first section we will discuss about the problem identification, then methodology in the second section, in the third section result then conclusion in the fourth section

Abbreviation: Some abbreviation like OSS (Oversampling smoothness), CDI (Coherent Diffraction imaging), ER Algorithm (Error Reduction), NR Algorithm (Noise Robust), HIO Algorithm (Hybrid Input Output).

2. Problem Identification

Although significant advances and developments have been made over the past few years to develop CDI methods and pursue their application in nanoscience, biology, and materials science it remains a challenge to reconstruct fine features in weakly scattering objects such as biological specimens from noisy experimental data. Existing system works for phase retrieval of linearly distributed noisy image it does not work for non linearly distributed noisy image also it does not provide any image enhancement of the reconstructed image.

3. Solution Methodology

This methodology works on noise free phase retrieval from linearly distributed noise of the oversampled diffraction pattern also it improves the retrieved phase by means of image enhancement filters. It also works for the non linearly distributed noise.

For Linearly Distributed Noise

Here an image is selected and (say 20%) poison noise is added linearly to the image and oversampled diffraction pattern of this noisy image is calculated. Now this noisy diffracted image is given as an input to the iterative phase retrieval OSS algorithm. After 1500 or more iterations the result is noise free phase information by which image is reconstructed but due to existence of noise it is now given for image enhancement through different filters where three different filters Inverse Filter, Weiner Filter, Lucy Richardson Filters give individually refined reconstructions. The outputs of all the three reconstructions are compared by means of MSE and PSNR values and a graph is plotted to visualize the reconstructions.

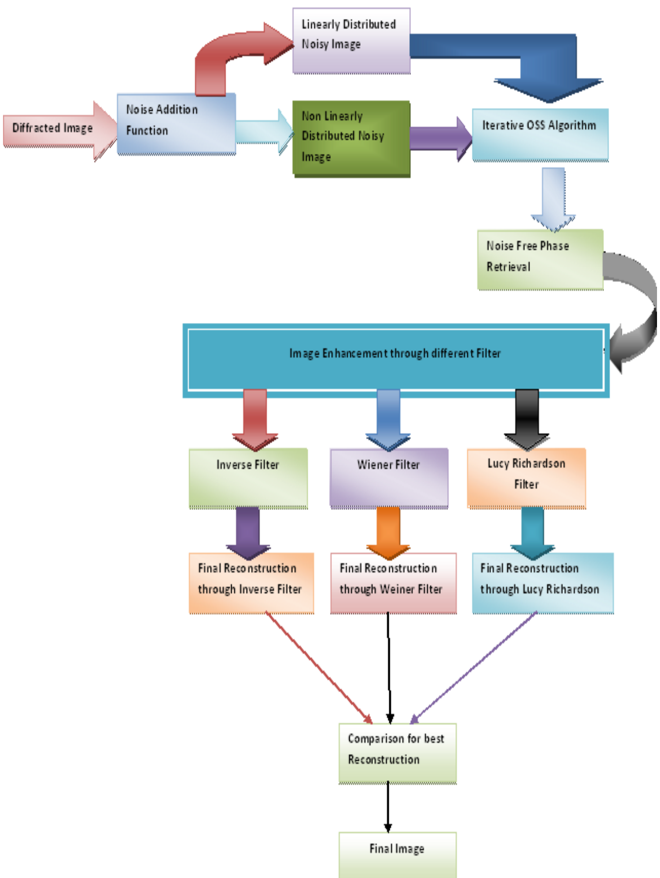

Figure 1: Process Flow Diagram

For Non-Linearly Distributed Noise

Image is selected and poison noise (say 20%) is added Non-linearly to the selected part of image now diffraction pattern of this noisy image is calculated. This noisy diffracted image is given as an input to the iterative OSS algorithm. After 1500 or more iterations the result is noise free phase information by which image is reconstructed but due to existence of noise it is now given for image enhancement through different filters where three different filters Inverse Filter, Weiner Filter, Lucy Richardson Filters give individually refined reconstructions. The outputs of all the three reconstructions are compared by means of MSE and PSNR values and a graph is plotted to visualize the reconstructions.

4. Result

After analyzing various images for linear and non linear noisy image the experimental values of MSE and PSNR for five sample images shows that the output generated by the inverse filtering gives better reconstruction, while the performance of other two wiener filters and Lucy Richardson filter gives near about reconstruction.

For Linear Noise						
Filter		Image Samples				
		1	2	3	4	5
Inverse	PSNR	54.9589	58.1579	56.1473	55.4831	53.3751
	MSE	0.20398	0.1003	0.15913	0.18543	0.30128
Weiner	PSNR	55.069	58.0997	55.4179	55.6163	53.30202
	MSE	0.20398	0.10151	0.18823	0.17983	0.30511
Lucy Richard	PSNR	54.7542	57.8144	55.932	55.7949	53.2388
	MSE	0.21931	0.1084	0.16722	0.17258	0.31088

The Graph shows the comparison of the performance of all the image enhancement filters. Comparison is done on the basis of the values of the MSE and PSNR of the individual filters.

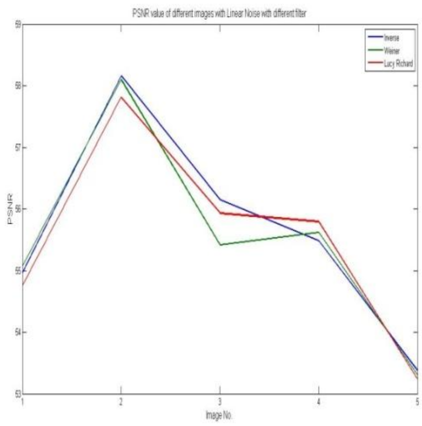

Figure 2: For Linear Distributed Noise the PSNR high for inverse filter

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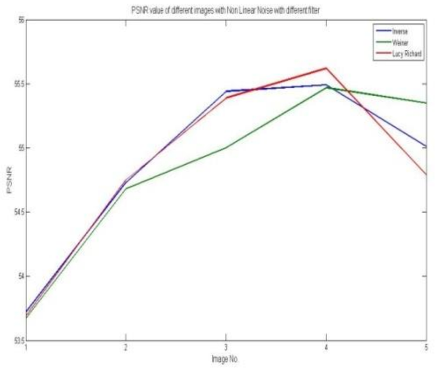

Figure 3: For linearly distributed MSE Least for Inverse filter

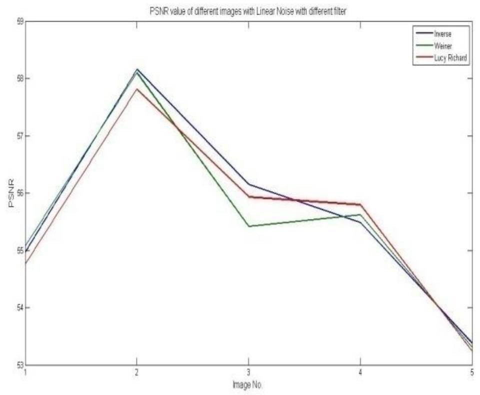

Figure 4: High PSNR for non-linearly distributed noise Inverse filter

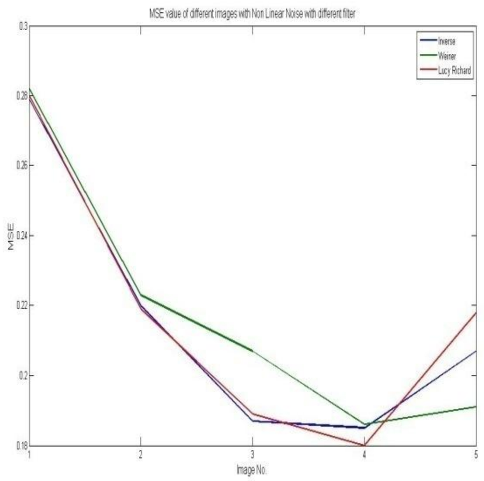

Figure 5: 4 Least MSE for inverse filter

For Non Linear Noise						
Filter		Image Samples				
		1	2	3	4	5
Inverse	PSNR	53.72	54.73	55.44	55.49	55.01
	MSE	0.279	0.22	0.187	0.185	0.207
Weiner	PSNR	53.67	54.68	55	55.47	55.35
	MSE	0.282	0.223	0.207	0.186	0.191
Lucy Richard	PSNR	53.69	54.75	55.39	55.62	54.79
	MSE	0.28	0.219	0.189	0.18	0.218

5. Conclusion

By applying iterative phase retrieval algorithms we cannot retrieve the actual phase of the signal (image) due to presence of noise but the retrieved phase is partial reconstruction of the input image along with noise. This noisy image can be enhanced by applying filtering technique by using filters. Here three filters are used to enhance the image they are Inverse filter, Wiener Filter, Lucy Richardson filter. Individually all the three filters process the image for enhancement and the output of all the three are compared for better reconstruction. By experimenting on different images for linearly /Non linearly distributed noisy diffracted image using Oss algorithm with image enhancement with different filters i.e. Inverse, Wiener, Lucy Richardson. Inverse filter gives better reconstruction then other two filters.

This work can be extended further by amalgamation of other phase retrieval algorithms and filtering techniques. This approach can be extended by applying on some specific images like medical images, satellite images, and biological images and under water images. Performance of this system can also be extended by using more number of image enhancement filters like Median Filter, Highpass Filter, and Lowpass Filter, etc to check for more consistency, accuracy and better reconstruction.
Present work can also be extended by adding different noise like Gaussian Noise, salt and pepper, Shot Noise, Anisotropic Noise etc

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