International Journal of Information Movement Vol.2 Issue II (June 2017)
Website: www.ijim.in ISSN: 2456-0553 (online) Pages 165-173

IMPROVED NON LOCAL MEANS METHOD FOR SONAR IMAGE DENOISING

Manpreet Kaur
Research Scholar, Faculty
Dept. of Elect. and Comm., Galaxy Global Groups of Institutions, Hry., India
Email: mkaur0506@gmail.com

Saranjeet Singh
Faculty
Dept. of Elect. and Comm., Galaxy Global Groups of Institutions, Hry., India
Email: mail2saranjeet@gmail.com

Abstract-Due to negative visibility conditions, the underwater rich in abundant useful resource is still no longer nicely explored. The imaging method is one of the technique to show the hidden treasure to the arena. For this cause optical imaging method is used. Optical photographs suffer from terrible visibility situation because of restrained variety of light and attenuation. So SONAR pix primarily based on acoustic or "echo sounding" principle, which suffers less attenuation, is used for exploring the underwater. Sonar images are affected by spatially various clutters. furthermore there is a strong ardour in understanding what lies in underwater, so facet scan SONAR device is used in underwater to capture the ocean floor which hides most of the treasure. Sonar pix performs a vital position in oil exploration, mine's detection navigation , seabed mapping , fishing , ocean drilling , and and so on. consequently it become a challenging assignment to submit system the captured sonar snap shots, which are at risk of speckle noises, ambient noises, and many others. consequently, the picture should be processed before segmentation, characteristic detection, that are the subsequent and substantial processes in picture analysis. To get rid of noise from the photograph without affecting the nice and edges, part maintaining filters ought to be utilized. The filtering techniques fulfill numerous processing steps for correcting non-uniform illumination, suppressing noise, improving assessment and adjusting colours.

Keywords: image Denoising, underwater imagery, sonar pix

1.0 Introduction

Sonar data are normally offered as gray level snap shots[1]. However, Sonar pix frequently display placing variations in brightness. These versions, due to the sonar beam pattern and the continuously converting attitude make the images tough to read as pictures of the seabed. This reduces the application of the photos for marine geologists. The Sonar is a effective, versatile however low fee tool for surveying the ocean floor. Commonly a ship tows a tow fish established with two sonar arrays, one on every aspect. The Sonar is a powerful, versatile but low cost tool for surveying the sea floor. Usually a ship tows a tow fish mounted with two sonar arrays, one on each side [2]. The Sonar arrays emit fan-fashioned sonar indicators perpendicular to the path of journey. The raw sonar facts are two time collection of digitized sound: the returned-scattered indicators from every ping at the port and starboard aspects of the tow fish. If we display the data as grey degree pixels representing the acoustic strength, the end result is a image similar to the left aspect of Fig.1.1 that is also known as a waterfall show.

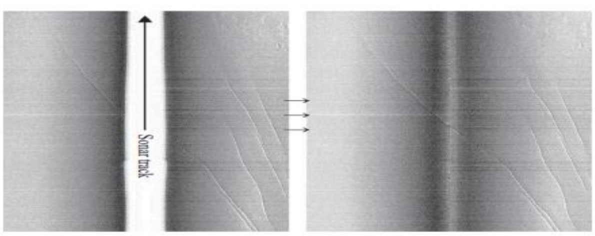


FIG. 1.1: Sonar Data Before And After Slant Range Correction[3]

The experiment range for every side is about 400 m. The terrain features shown are numerous elongated small ordinary faults on a slope of sea bottom.

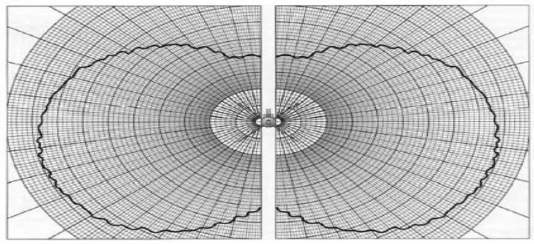


Figure 1.2: A typical beam pattern for Sonar equipment[3]

The solid curves represent the relative intensity of sonar emission in different directions.

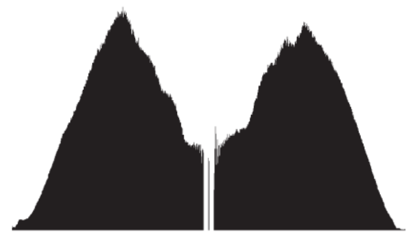


Fig. 1.3: Back-scattered energy as a function of grazing angle[3]

The horizontal axis denotes the grazing perspective; the vertical axis denotes the relative intensity.

2.0 Literature Survey

Tan j., et. al. (2015) worked on the compressive imaging troubles, where photographs are reconstructed from a reduced quantity of linear measurements. The goal is to improve over existing compressive imaging algorithms in terms of each reconstruction error and runtime. To pursue our objective, we advocate compressive imaging algorithms that appoint the approximate message passing (AMP) framework. AMP is an iterative sign reconstruction algorithm that performs scalar denoising at each generation; so as for AMP to reconstruct the original input sign well, a terrific denoiser must be used. We apply wavelet-based totally photo denoiser inside AMP. The first denoiser is the "amplitude-scale-invariant Bays estimator" (ABE), and the second is an adaptive Wiener filter; we call our AMP-primarily based algorithms for compressive imaging AMP-ABE and AMP-Wiener. Numerical results display that both AMP-ABE and AMP-Wiener considerably improve over the country of the art in terms of runtime. In terms of reconstruction fine, AMP-Wiener offers decrease suggest-rectangular error (MSE) than present compressive imaging algorithms. In comparison, AMP-ABE has better MSE, due to the fact ABE does now not denoiser in addition to the adaptive Wiener filter out [11]. Therefore **Zhao Y.Q., et. al. (2015)** worked on Hyper spectral picture (HSI) denoising is an vital preprocess step to improve the overall performance of subsequent applications. For HSI, there's lots international and nearby redundancy and correlation (RAC) in spatial/spectral dimensions. In addition, denoising overall performance may be advanced greatly if RAC is utilized correctly within the denoising process. In this paper, an HSI denoising method is proposed via collectively utilizing the global and local RAC in spatial/spectral domain names. First, sparse coding is exploited to version the global RAC inside the spatial area and neighborhood RAC within the spectral domain. Noise can be eliminated by sparse approximated information with learned dictionary. At this level, simplest neighborhood RAC within the spectral area is hired. It will reason spectral distortion. To compensate the lack of neighborhood spectral RAC, low-rank constraint is used to deal with the worldwide RAC within the spectral domain. Different hyper spectral data units are used to check the performance of the proposed approach. The denoising effects by the proposed technique are superior to results obtained by using other latest hyper spectral denoising strategies [12]. After that **Cheng W., et. al. (2015)** presented a pixel values of pictures taken with the aid of an image sensor are said to be corrupted with the aid of Poisson noise. To date, multiscale Poisson photo denoising strategies have processed Haar frame and wavelet coefficients-the modeling of coefficients is enabled by means of the skellam distribution evaluation. We increase those results by fixing for shrinkage operators for Skellam that minimizes the danger purposeful within the multiscale Poisson photograph denoising placing. The minimum threat shrinkage operator of this kind efficiently produces denoised wavelet coefficients with minimum manageable L2 errors [13].Therefore **Censor W., et. al. (2016)** took the implicit convex feasibility hassle attempts to find a factor in the intersection of a finite family of convex sets, some of which aren't explicitly decided however may additionally vary. We expand simultaneous and sequential projection strategies capable of dealing with such problems and display their applicability to picture denoising in a selected medical imaging state of affairs. By allowing the variable units to go through scaling, transferring and rotation, this paintings generalizes preceding consequences wherein the implicit convex feasibility trouble became used for cooperative wi-fi sensor community positioning in which units are balls and their centers had been implicit [14]. After that **Hassani A., et. al. (2016)** [15] The green Non-Local Means denoising set of rules modifies the depth of each pixel by way of the weighted common of all comparable pixels within the noisy photo. It stems from the assumption that there are many comparable systems in sonar pix. Many adaptations of the NLM filter out has been broadly used for MRI picture denoising. The Unbiased NLM is a popular this type of techniques which subtracts the Rican noise bias from the NLM filtered image. The bias can be expected from the MRI picture background. Prior to that, the heritage wishes to be extracted from the photo. However, the envisioned Rican noise bias depends strongly at the segmentation technique which influences the set of rules overall performance. In this work, we recommend an accurate segmentation based totally on morphological reconstruction to split the picture into two regions-foreground and background. Initially, we endorse a dynamic structuring element which the shape adapt according to the input image to keep away from the hassle of choosing the suitable structuring element. The obtained historical past is used to estimate the noise bias while the Unbiased NLM filter is implemented topically at the received foreground the use of the estimated bias. Experimental effects show that the proposed method perform better than the NLM clear out and the UNLM underneath all examined noise tiers [15]. After that **Jain S. K., et. al. (2016)** They deals with an anisotropic diffusion primarily based noise elimination approach which makes use of the new diffusion characteristic primarily based on tangent sigmoid function. A local part indicator feature based totally on local shape tensor is likewise used in the proposed method, to reduce the noise and detection of edges in virtual pix. From the experimental effects, we look at that the proposed approach is better and close to to the alternative cutting-edge methods, in phrases of both qualitatively and quantitatively. Numerical checks had been performed on diverse photographs, which can be corrupted by using Gaussian noise and consequences illustrate that the proposed method is greater green than current one [16].Therefore **Xiaoming L., et. al. (2017)** worked on image denoising is a essential step earlier than acting segmentation or function extraction on an photograph, which influences the very last bring about photograph processing. In recent years, utilizing the self-similarity traits of the pics, many patch-primarily based picture denoising strategies have been proposed, but most of them, named the internal denoising techniques, utilized the noisy photograph only where the performances are restrained by means of the constrained facts they used. We proposed a patch-based totally technique, which uses a low-rank method and targeted database, to denoised the optical coherence tomography (OCT) photograph. When choosing the similar patches for the noisy patch, our technique mixed inner and outside denoising, utilizing the alternative photographs applicable to the noisy picture, in which our centered database is made up of those varieties of photographs and is an development compared with the previous techniques. Next, we leverage the low-rank method to denoised the group matrix which include the noisy patch and the corresponding similar patches, for the reality that a easy photograph may be visible as a low-rank matrix and rank of the noisy picture is a lot large than the smooth photo. After the first-step denoising is completed, we take advantage of Gabor remodel, which taken into consideration the layer characteristic of the OCT retinal photographs, to construct a loud image earlier than the second step. Experimental results display that our method compares favorably with the prevailing brand new techniques [17]. After that **Ahn B., et. al, (2017)** worked on the image denoising is a crucial step earlier than appearing segmentation or feature extraction on an image, which affects the final result in photograph processing. In current years, making use of the self-similarity traits of the photographs, many patch-based totally image denoising techniques were proposed, but maximum of them, named the internal denoising strategies, utilized the noisy photo handiest where the performances are restricted via the limited facts they used. We proposed a patch-primarily based technique, which uses a low-rank approach and targeted database, to denoised the optical coherence tomography (OCT) photo. When selecting the same patches for the noisy patch, our approach mixed internal and outside denoising, utilizing the alternative pix applicable to the noisy photo, wherein our centered database is made up of those types of images and is an development compared with the preceding strategies. Next, the low-rank approach to denoised the organization matrix along with the noisy patch and the corresponding comparable patches, for the fact that a smooth picture may be seen as a low-rank matrix and rank of the noisy photograph is a good deal larger than the clean image. After the first-step denoising is performed, we take advantage of Gabor transform, which considered the layer feature of the OCT retinal pictures, to assemble a loud picture earlier than the second one step. Experimental results display that our technique compares favorably with the present today's techniques. Non-local means is an algorithm in image processing for image denoising. Unlike "local mean" filters, which take the mean value of a group of pixels surrounding a target pixel to smooth the image, non-local means filtering takes a mean of all pixels in the image, weighted by how similar these pixels are to the target pixel. Recently non-local means has been extended to other image processing applications such as deinterlacing and view interpolation [18].

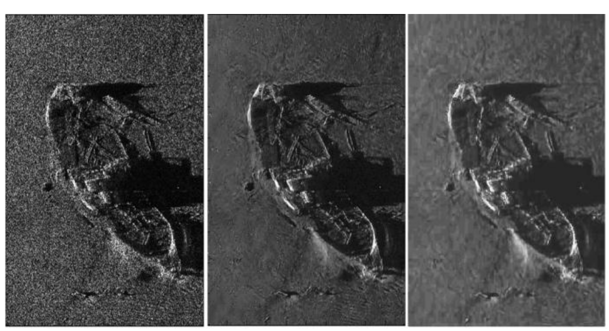
3.0 Noise Reduction

Noise discount is the process of eliminating noise from a signal [4]. All recording devices, both analog and digital, have tendencies that cause them to at risk of noise. Noise can be random or white noise and not using a coherence, or coherent noise added by the device's mechanism or processing algorithms. In digital recording gadgets, a main form of noise is hiss as a result of random electrons that, heavily influenced by using heat, stray from their special direction. These stray electrons influence the voltage of the output signal and as a consequence create detectable noise.

in the case of photographic movie and magnetic tape, noise (each visible and audible) is introduced because of the grain shape of the medium. In photographic film, the dimensions of the grains within the movie determine the movie's sensitivity, greater sensitive film having larger sized grains. To compensate for this, larger areas of film or magnetic tape may be used to lower the noise to an acceptable level [5]. In magnetic tape, the bigger the grains of the magnetic particles (normally ferric oxide or magnetite), the greater susceptible the medium is to noise. Many noise reduction algorithms have a tendency to damage more or much less alerts. The neighborhood sign-and-noise orthogonalization Algorithm set of rules can be used to keep away from the damages to indicators [6].

3.1 Noise reduction in photos

Noise is the end result of mistakes in the image acquisition technique that result in pixel values that don't mirror the real intensities of the actual scene. Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, depending on how the image is created. For example: If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise can also be the result of damage to the film, or be introduced by the scanner itself. A back draw of the linear models is that they are not able to preserve edges in a good manner: edges, which are recognized as discontinuities in the image, are smeared out [7]. Nonlinear models on the other hand can handle edges in a much better way than linear models can. One popular model for nonlinear image denoising is the Total Variation (TV)-filter. This filter is very good at preserving edges, but smoothly varying regions in the input image are transformed into piecewise constant regions in the output image. Using the TV-filter as a denoiser leads to solving a 2nd order nonlinear PDE [8].



(a) (b) (c)

Fig. 2.1: (a) First image is with noise, (b) middle image is original image and (c) the rightmost image is the restored image[9]

The first image is noisy image, and middle image is original image, and the rightmost photo is the restored picture the use of the 4th order version. Some other approach is to combine a 2d and 4th order method. The idea right here is that smooth areas are filtered by way of the 4th order scheme, whilst edges are filtered via a 2d order scheme. To choose wherein areas of the photograph each of the models are to be used, one has to construct a weight characteristic. some other manner of denoising pics is the following: as opposed to running immediately with the photographs, the noisy regular vectors of the image are processed as a substitute. Then, the smoothed everyday vectors are used to reconstruct a denoised picture. This approach offers excellent results. The procedure is illustrated here:

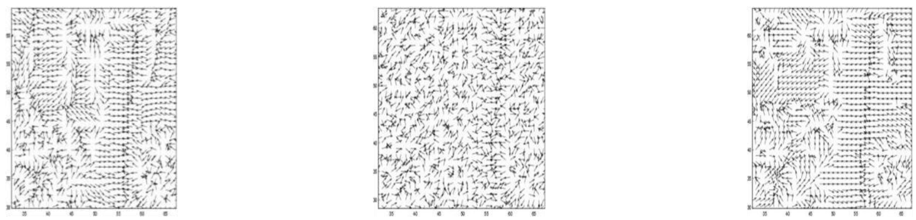


Fig. 2.2: The Normals of the original image, the middle image shows the normals of the noisy image, and the last image shows the smoothed normals[10]

The 3 photos above show a small excerpt of the regular vectors of the above proven picture. the primary photo suggests the normals of the unique photograph, the center image suggests the normals of the noisy photo, and the ultimate image indicates the smoothed normals.

4.0 Various Sources of Noise in Snap Shots

Noise is delivered within the image on the time of photograph acquisition or transmission. Different factors may be responsible for creation of noise in the photograph. The quantity of pixels corrupted inside the picture will decide the quantification of the noise. The fundamental sources of noise inside the virtual picture are:

a) The imaging sensor can be suffering from environmental situations for the duration of picture acquisition.
b) Inadequate mild degrees and sensor temperature may introduce the noise within the image.
c) Interference in the transmission channel can also corrupt the picture.
d) If dust debris are gift at the scanner display, they could also introduce noise inside the photo.

Noise is the undesirable results produced inside the picture. during image acquisition or transmission, numerous elements are chargeable for introducing noise inside the image. depending at the form of disturbance, the noise can have an effect on the photograph to different quantity. typically our focus is to do away with sure kind of noise. So we discover positive sort of noise and follow distinct algorithms to do away with the noise. photo noise can be categorized as Impulse noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noise, Quantization noise (uniform noise), movie grain, on-isotropic noise, Multiplicative noise (Speckle noise) and Periodic noise.

4.1 Impulse Noise (Salt and Pepper Noise)

The time period impulse noise is likewise used for this form of noise. other terms are spike noise, random noise or unbiased noise. Black and white dots appear within the photo due to this noise and therefore salt and pepper noise This noise arises in the photo because of sharp and unexpected changes of image signal. Dust debris inside the photo acquisition source or over heated defective components can motive this sort of noise. Image is corrupted to a small quantity because of noise.

.

Figure 4.1: Original image[11]

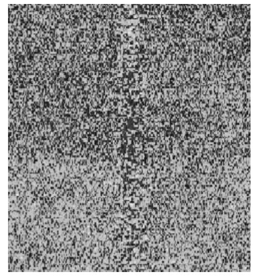


Figure 4.2: Image with 20% salt & pepper noise[11]

4.2 Gaussian Noise (Amplifier Noise)

The time period ordinary noise model is the synonym of Gaussian noise. This noise model is additive in nature and comply with Gaussian distribution. That means every pixel inside the noisy photograph is the sum of the proper pixel price and a random, Gaussian disbursed noise value. The noise is impartial of depth of pixel value at every point. The PDF of Gaussian random variable is given by:

P(x) =1/($\sigma\sqrt{2\pi}$) *$e^{(x-\mu)2}$ /2σ^2 $^{-\infty <}$ $0 < \infty$

where: P(x) is the Gaussian distribution noise in image; μ and σ is the suggest and well known deviation respectively.

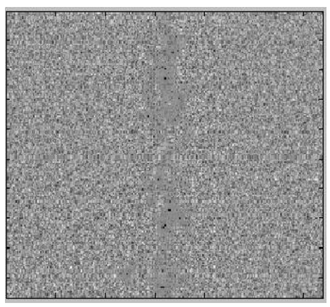


Figure 4.3: Gaussian noise with zero mean[12]

4.3 Poisson Noise (Photon Noise)

Poisson or shot photon noise is the noise that may purpose, when wide variety of photons sensed via the sensor is not enough to provide detectable statistical data. This noise has root mean rectangular fee proportional to square root depth of the photograph. Exceptional pixels are suffered by using unbiased noise values. At practical grounds the photon noise and other sensor based totally noise corrupt the sign at exceptional proportions. Discern four indicates the end result of adding Poisson noise [13].

4.4 Speckle Noise

This noise may be modeled by random value multiplications with pixel values of the photograph and may be expressed as in which, J is the speckle noise distribution image, I is the enter image and n is the uniform noise image by way of mean o and variance v.

J = I+N*I

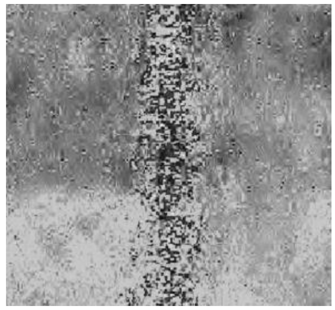


Figure 4.4: Image with Poisson noise[13]

This noise deteriorates the quality of active radar and synthetic aperture radar (SAR) photographs. This noise is originated due to coherent processing of again scattered signals from multiple allotted factors. In conventional radar machine this type of noise is observed while the back sign from the object having size much less than or same to a unmarried photo processing unit, shows surprising fluctuations. Imply filters are right for Gaussian noise and uniform noise. Fig 4.5 indicates the effect of adding speckle noise.

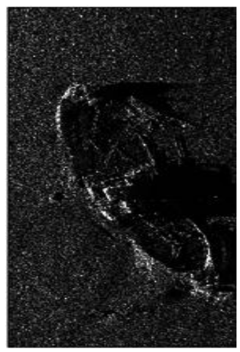


Figure 4.5: Image with speckle noise[14]

5.0 5.0 Methods of Sonar Image Denoising

6.0

7.0 5.1 Beam pattern correction

The most outstanding feature of Sonar photographs is the too robust intensity near the course of the towfish, and the weak reaction at the outer part of the swath that is resulting from the beam pattern of the sonar. A standard Sonar beam pattern is proven in Fig. 5.1. Throughout the swath, the quantity of sonar electricity hitting the seabed will vary with the space from the towfish. The attitude at which the sonar wave hits the sea floor (grazing perspective) also varies. The uncooked Sonar facts are the lower back-scattered strength from the seabed; each the extent of incident electricity and grazing angle will affect the data. One easy way to discover the strength distribution is to sum up the strength tiers for each attitude over the complete facts series. The image before and after this correction are shown in Fig. 5.1. The undesirable version throughout the swath has been successfully eliminated. Maximum processing processes for the equal photograph correction cause are achieved by way of time variable profits (TVG), both at source or in publish-processing. However, the time based totally functions aren't suitable to explain the variation of backscattering power which is largely controlled with the aid of the grazing perspective. For example, the TVG's have to be continuously adjusted to evolve the intensity changes. with in the other hand, the proposed method based on grazing attitude in this paper would be almost invariant with the depth. It appears to be a extra convenient and theoretically right method for maximum records processors.

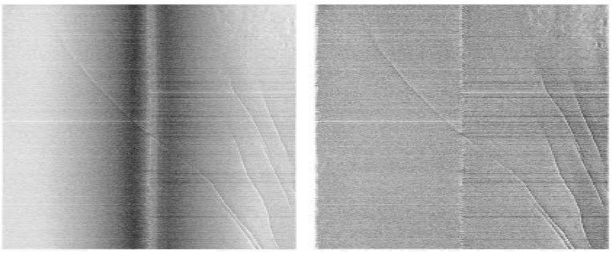


Figure 5.1: Images before and after beam pattern correction[3]

because the feature of beam pattern right here was hooked up by using summing up the statistics set itself, it become viable to rule out some real signals right at certain grazing perspective by way of this technique. but, the opportunity of certain indicators constantly appear round sure grazing perspective is rare. In most instances, the method has provided proper overall performance.

5.2 Ping Energy Level Normalization

The strength broadcast via the sonar array need to be exactly the same for every ping. but, as the towfish is pulled underneath the water, it is continuously moving due to waves.

Figure 5.2: Overall ping power levels. The horizontal axis denotes the collection pings and the vertical axis denotes the average intensity of every ping [3]

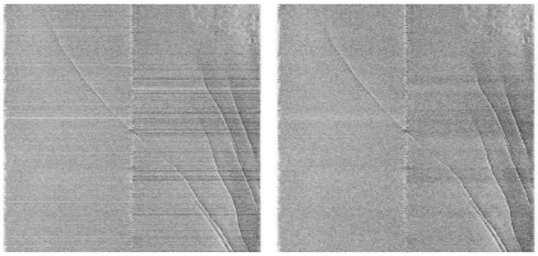


Figure 5.3: Images before and after the ping energy level normalization currents[3]

This reasons the energy surely incident on the ocean floor to differ from ping to ping. Fig.5.3 shows the images before and after the ping energy level normalization currents The extent of back-scattered power additionally modifications with the surface man or woman of the seabed. So the strength stages can exchange suddenly between pings, and these abrupt modifications display up because the white and black horizontal traces in Fig.5.2.

To suppress this sort of noise, we assume that every ping "should" have a similar electricity stage to the pings earlier than and after it. The entire again-scattered power stage for every ping is calculated, and represented as the histogram in Fig. eleven. For every ping, we discover the common energy stage of the 20 pings before and after it.

6.0 References

1. Tardos J. D., et.al., "Robust mapping and localization in indoor environments using sonar data,"*The International Journal of Robotics Research 21.4,* pp.311-330, 2002.
2. Preston J. M., "Stability of towfish used as sonar platforms," OCEANS'92, *Mastering the Oceans Through Technology. Proceedings.*Vol. (2), 1992.
3. Mittermayer J. and Moreira A., "Spotlight SAR data processing using the frequency scaling algorithm" *IEEE Transactions on Geosciences and Remote Sensing 37.5,*pp.2198-2214, 1999.
4. Chang Y.C.,Hsu S.K.and Tsai C.H., "Side scan sonar image processing: correcting brightness variation and patching gaps," *Journal of marine science and Technology 18.6,* pp.785-789, 2010.
5. Benesty J, et.al., "Study of the Wiener filter for noise reduction," *Speech Enhancement,* pp 9-41, 2005.
6. Vaseghi S.V., "Advanced digital signal processing and noise reduction,"John Wiley & Sons, 2008.
7. Guo J., et.al., "Shadow Extraction from High-Resolution Remote Sensing Images Based on Gram-Schmidt Orthogonalization in Lab Space," *3rd International Symposium of Space Optical Instruments and Applications. Springer, Cham.,* 2017.
8. Portilla J., et.al., "Image denoising using scale mixtures of Gaussians in the wavelet domain," *IEEE Transactions on Image processing 12.11* , pp.1338-1351, 2003.
9. Nonlinear models on the other hand can handle edges in a much better way than linear models can. One popular model for nonlinear image denoising is the Total Variation (TV)-filter.
10. Isar A., et.al., "SONAR Images Denoising," Sonar Systems in Tech, 2011..
11. Tan J., Ma y. and Baron D., "Compressive imaging via approximate message passing with image denoising." *IEEE Transactions on Signal Processing 63.8,*pp. 2085-2092, 2015.
12. Zhao Y Q. and Yang J., "Hyper spectral image denoising via sparse representation and low-rank constraint,"*IEEE Transactions on Geosciences and Remote Sensing 53.1,* pp. 296-308, 2015.
13. Cheng W. and Hirakawa K., "Minimum risk wavelet shrinkage operator for poisson image denoising," *IEEE Transactions on Image Processing 24,* pp.1660-1671, 2015
14. Censor Y., Gibali A. and Lenzen F., "The Implicit Convex Feasibility Problem and Its Application to Adaptive Image Denoising," *arXiv preprint arXiv:1606.05848*, 2016.
15. El Hassani A. and Majda A., "Efficient image denoising method based on mathematical morphology reconstruction and the Non-Local Means filter for the MRI of the head," *IEEE International Colloquium on Information Science and Technology (CIST),* 2016.
16. Xiaoming L., et. al., "Patch-based denoising method using low-rank technique and targeted database for optical coherence tomography image," *Journal of Medical Imaging 4.1,* pp. 014002-014002, 2017.