Efficient Image Enhancement Using Hybrid Wavelet Technique

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Abstract— Image enhancement models have been in vogue since digitization but stable techniques for image enhancements have not emerged as inherent problems persist and one of the major problems include multiplicative noise also referred to as speckle noise and blurred models which are central to the study of coherent imaging systems, such as synthetic aperture radar and sonar, and ultrasound and laser imaging. These models introduce two additional layers of difficulties with respect to the standard noise scenario, one is the noise is multiplied by the original image and the other is that the noise is not Gaussian. These features of multiplicative noise models preclude the direct application of most state-of-the-art algorithms, which are designed for solving unconstrained optimization problems where the objective has two terms - a quadratic data term by reflecting the additive and nature of the noise, plus a non-smooth regularize, which may be a total variation or wavelet-based Regularizer /prior). The model proposes to address these difficulties by converting the multiplicative model into a hybrid one to obtain an enhanced noise removed image and optimize the image.

Key words: Image Enhancement, Noise Removal, Blur, Noise

I. SPECKLE NOISE

Speckle noise is a granular noise that inherently exists in and degrades the quality of the active radar and synthetic aperture radar (SAR) images. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area.

Speckle noise in SAR is generally more serious, causing difficulties for image interpretation.[12] It is caused by coherent processing of backscattered signals from multiple distributed targets. In SAR oceanography, for example, speckle noise is caused by signals from elementary scatterers, the gravity-capillary ripples, and manifests as a pedestal image, beneath the image of the sea waves.

Several different methods are used to eliminate speckle noise, based upon different mathematical models of the phenomenon.[3] One method, for example, employs *multiple-look processing* (a.k.a. *multi-look processing*), averaging out the speckle noise by taking several "looks" at a target in a single radar sweep.[12] The average is the *incoherent average* of the looks.[2]

A second method involves using adaptive and non-adaptive filters on the signal processing (where adaptive filters adapt their weightings across the image to the speckle level, and non-adaptive filters apply the same weightings uniformly across the entire image). Such filtering also eliminates actual image information as well, in particular high-frequency information, and the applicability of filtering and the choice of filter type involves tradeoffs. Adaptive speckle filtering is better at preserving edges and detail in high-texture areas (such as forests or urban areas). Non-adaptive filtering is simpler to implement, and requires less computational power, however.[12]

There are two forms of non-adaptive speckle filtering: one based on the mean and one based upon the median (within a given rectangular area of pixels in the image). The latter is better at preserving edges whilst eliminating noise spikes, than the former is. There are many forms of adaptive speckle filtering, including the Lee filter, the Frost filter, and the Refined Gamma Maximum-A-Posteriori (RGMAP) filter. They all rely upon three fundamental assumptions in their mathematical models, however.

II. PROPOSED MODEL

The basic motivation is to find a representation which decor relates the image pixels, in order to design an efficient compressed code. Being over complete, the multi resolution underperforms compression techniques that provide critical representations, such as wavelets. However, the over complete representation allows more degrees of freedom for the design of filters, allows the multi resolution to support multiple reconstruction methods, and reduces aliasing in the high frequency sub bands. Additionally, the multi resolution representation makes the multi resolution particularly useful for progressive image transmission. The multi resolution represents an image as a hierarchy of difference images. First, a coarse approximation of the original image is used to generate a prediction, which is then subtracted from the original image to obtain a difference image, or a detail image. The process is iterated on the coarse image for further levels of decomposition. Each difference image is reduced in both resolution and sample density, hence the pyramid structure. A down sampled, coarse approximation of the original image is added at the top of the pyramid. Each pyramid level corresponds to a different sub band of image frequencies. For effective compression, all the sub bands are quantized and entropy-coded before transmission or storage. A simple reconstruction method is to regenerate the prediction based on the coarse image and add it back to the difference image.

III. ALGORITHM

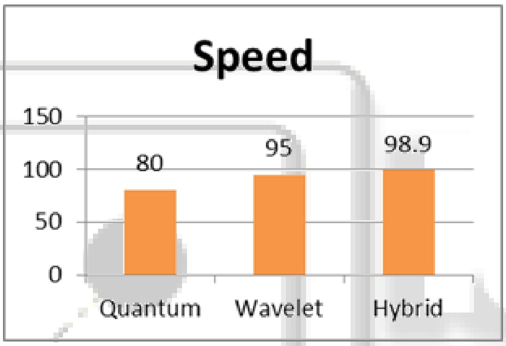
- Technique is to low-pass filter the original image
- Image Decomposition is done on aperture size.
- Signal Component is first Separated.
- Noise Components is then Separated next.
- For each Pass the wavelets are computed.
- High Frequency Wavelets are Removed – variable splitting
- Low Frequency wavelets are retained.
- Signal Reconstruction is done minus the speckles.

- Original Image is retained with Scale Reconstruction.

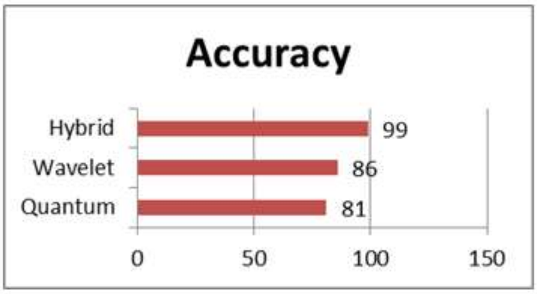
IV. Comparitive Table

Data without loss at any stage of this technique Correlated neighboring pixels of an image can be decorrelated to enhance the image features. The method id more effective than thresholding method. More accurate Signal Reconstruction is achieved in each scale No resolution loss occurs. Image Scene preservation is excellent. Computational load is less when compared with other Bayesian algorithms

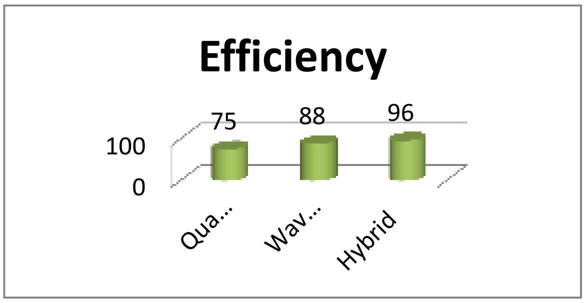
Methods	Speed	Accuracy	Efficiency
Quantum	80	81	75
Wavelet	95	86	88
Hybrid	98.9	99	96



The speed with which the image enhancement happens is in our hybrid method which justifies the quantum of the level of pixels and the noise reduction ratio. Both wavelet and quantum methods are left way too behind.



The next factor parameter is accuracy with which the image noise removal takes place and here also the hybrid method has 99% accuracy while both wavelet and quantum methods are with 86% and 81% respectively.



Finally we come to the factor of efficiency with which noise is removed. The hybrid method has 96% accuracy for all sorts of images while the quantum and wavelet methods have 75% and 88% effectiveness only.

V. Conclusion

Thus the wavelet system based on novel hybrid method for speckle suppression and enhancement of images by deblurring and effective noise removal is implemented. In the proposed model involves the processing steps like the Synthetic Aperture Radar SAR image which is decomposed into several scales through a multi resolution analysis employing the 2-D wavelet transform. After decomposing the original image, the signal and noise components in various scales are modeled as Wavelet, Laplace and Gaussian processes, respectively.

A new approach to solve the optimization problem resulting from variational estimation of images observed under multiplicative noise models. Although the proposed formulation and algorithm can be used with other priors (namely, frame-based), here we have focused on total-variation regularization. Our approach is based on two building blocks: (1) the original unconstrained optimization problem was first transformed into an equivalent constrained problem, via a variable splitting procedure; (2) this constrained problem was then addressed using an augmented Lagrangian method, more specifically, the alternating direction method of multipliers (The parameters of the proposed model and noise distribution are estimated from the measurements. The proposed optimized muti resolution technique out forms well as compared to existing methods with very lower computational overheads and better resolution is retained in the technique.

VI. Future Enhancements

The entire project can be implemented as a web service in the future, thereby enabling the users to create their own objects and reutilize them in their respective domains. The project can be further extended to satellite imagery done in different probing missions using satellites. The project can also be extended to remove speckles in video images where the films get noisy by repeated usage over a period of time. The images can be saved in different formats after the noise cleaning.

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