A Study on the Application Of Wavelet Transformation to Preprocess Sonar Images Through Noise Removal

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Abstract- Under water environments are dynamic and complex, and obtaining a clear picture of the obstacles and movements of objects in this environment is difficult. The disturbances caused by various factors affect the image quality which leads to incorrect analysis. Sonar image quality can be assessed in terms of quality parameters like contrast, illumination variation and Noise. A non-parametric statistical wavelet denoising method is proposed in this paper. The proposed method incorporates the edge coefficients and non-edge coefficients as it picks up the homogeneous neighbor of non-edge coefficients and estimate the noise-free coefficients and outperforms the traditional approach.

Index Terms- Non-Parametric, wavelet, denoising

I. Introduction

Sonar images are often disturbed by various factors like transmission of limited range of light, disturbance of lightening, low contrast and blurring of image, color diminishing during capturing and noise. Wavelet based algorithms are proved to be effective for tackling speckle noise in sonar. The noise free coefficients are estimated by identifying the homogeneous neighbor using intra-scale and inter-scale dependencies. Finally the denoised image is reconstructed by performing an inverse wavelet transform.

Since the proposed non-parametric statistical denoising algorithm uses more efficient wavelet transforms incorporated with a hybrid intr-scale and intra-scale dependencies which produce comparatively better results.

This paper is organized as follows Section introduction, section II proposes a non-parametric statistical model which uses more efficient wavelet transforms. Experimental results are presented in section III, to justify that the proposed model proves better results than the traditional methods . Section IV concludes this paper.

The traditional denoising methods using wavelet coefficients proves to be less accurate compared to the improved wavelet transformations like discrete wavelet transformation, stationary wavelet transformation, complex wavelet and Dual tree wavelet transformation.

Wavelet transformation decomposes a signal in to a set of basic functions. These basic functions are called wavelets. The wavelet transform is computed separately for different segments of the time domain signal at different frequencies. Wavelets are obtained from a single prototype wavelet Y(t) called mother wavelet by dilation and shifting .

DWT transforms a discrete time signal to a discrete wavelet representation . It converts an input series $x_{0,}x_{1,}x_{2 \ldots\ldots}x_m$ in to one high-pass wavelet coefficient series and one Low-pass coefficient series

$$H_i = \sum^{k-1}{}_{m=0} X_{2i}\text{-m } S_m(Z)$$

$$L_i = \sum^{k-1}{}_{m=0} X_{2i}\text{-m } T_m(Z)$$

$S_m(Z)$ and $T_m(Z)$ are called wavelet filters, K is the length of the filter and i=0,1,….[n/2]-1.

Integer DWT: A more efficient approach to a lossless compression , coefficients are represented by a finite number. It allows lossless encoding and reduce the number of bits for the sample storage and to use simpler storage units.

Stationary wavelet Transform: The Stationary wavelet transform (SWT) is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transform (DWT). Translation-invariance is achieved by removing the down samplers and up samplers in the DWT and up sampling the filter coefficients by a factor of 2^{j-1} in the j^{th} level

Complex wavelet transform: The complex wavelet transform (CWT) is a complex-valued extension to the standard discrete wavelet transform (DWT). It is a two-dimensional wavelet transform which provides multiresolution, sparse representation, and useful characterization of the structure of an image. Further, it purveys a high degree of shift-invariance in its magnitude

II. Proposed Image Denoising Approach

Let I be the input corrupted sonar image, I' be the enhanced output image and ⊕ be the enhancement operation. The research problem is to Construct enhancement models of the form I' = ⊕ (I)

where ⊕ is a function that uses enhanced image processing techniques to transforms I to its enhanced version, I'. Further, the enhancement operator should improve the input image in a fast manner, while at the same time preserve the edge and quality without losing important information required during analysis and interpretation

To propose denoising filters that removes speckle and salt and pepper noise accumulated during acquisition of sonar images. To propose image fusion techniques that select quality pixels from a set of images belonging to the same scene and create a new improved enhanced image.

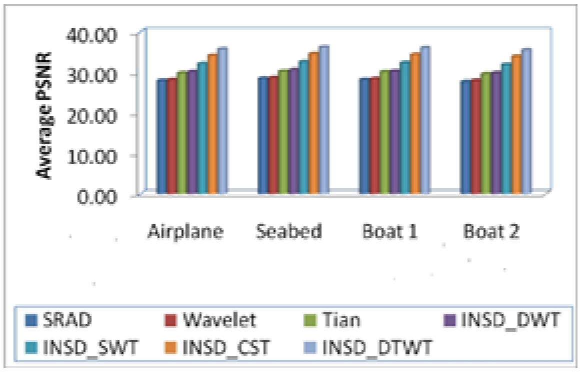
To propose lighting and illumination variation correction algorithms that can maintain edge and quality of input image in an efficient manner. To propose border enhancement techniques that improves the quality of edges.

III. EXPERIMENTAL RESULTS

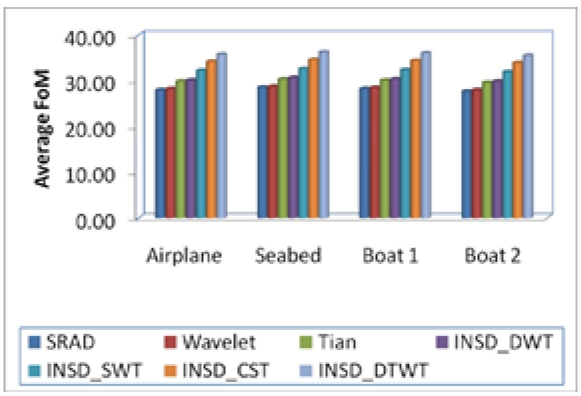
The non-parametric statistical wavelet denoising uses log transformation and identify the edge and non-edge coefficients which identify noise free coefficients.

The performance metrics used here are Peak signal to Noise ratio(PSNR) , Pratt's Figure Of Merit (FOM) , and Mean Structural Similarity Index (MSSI)

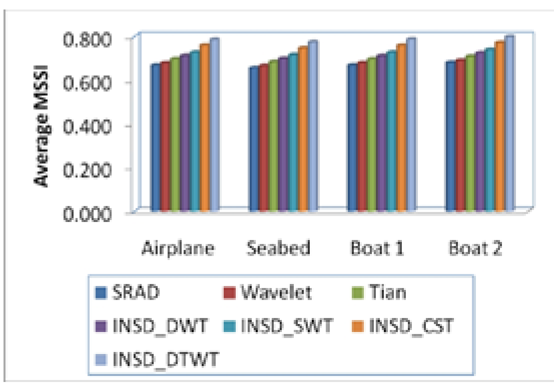
Average PSNR



Average FoM



Average MSSI

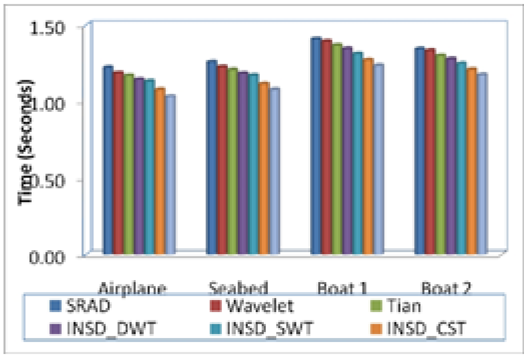


The existing Tian model uses antshrink algorithm in which only the inter-scale dependencies of the wavelet coefficients are considered. This is given by Jing Tian[1], Li Chen and L.Ma in A wavelet-domain non-parametric statistical approach for image

denoising. The proposed model is enhanced by a method that combines both intra-scale and inter-scale dependency of the wavelet coefficients.

Corrupted images were obtained by varying noise density from 0.1% to 0.9% in steps of 0.1. Denoising time is calculated as time taken by the proposed algorithm to complete the denoising operations. The graph below depicts the time taken for the proposed method compared the existing and the traditional methods.

Average Speed

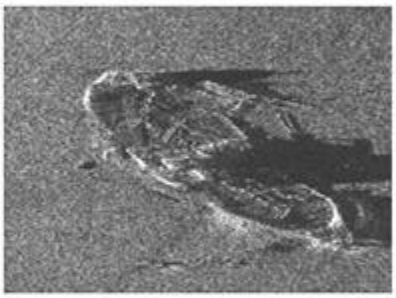


The above graph is drawn for all the four sample images selected which is given below. The Noise density is varied for each sample image from 0.1% to 0.9%. The resulting images shows improvement in the percentage of noise removed compared to the existing Tian model and the traditional wavelet.

Airplane

Seabed

Boat 1



Boat 2

IV. Conclusion

The above results shows that the proposed method using the non-parametric statistical wavelet denoising method proves to be better in removing speckle noise compared to traditional wavelet coefficients with less processing time which is shown in the above graph. Four sample images are taken into consideration and the results are produced by applying the proposed algorithm. The comparisons are made with the traditional wavelets, existing method and the proposed method with the above said three performance metrics.

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