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Two-Dimensional Wavelet Transform De-noising and Combining with Side Scan Sonar Image

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Abstract
This paper puts forward an image de-noising method based on 2D wavelet transform with the application of the method in seabed identification data collection system. Two-dimensional haar wavelets in image processing presents a unified framework for wavelet image compression and combining with side scan sonar image. Seabed identification target have 7 target detection in side scan sonar imagery result. The vibration signals were analyzed to perform fault diagnosis. The obtained signal was time-domain signal. The experiment result shows that the application of 2D wavelet transform image de-noising algorithm can achieve good subjective and objective image quality and help to collect high quality data and analyze the images for the data center with optimum effects, the features from time-domain signal were extracted. 3 vectors were formed which are v1, v2, v3. In Haar wavelet retained energy is 93.8 %, so from the results, it has been concluded that Haar wavelet transform shows the best results in terms of Energy from De-noised Image processing with side scan sonar imagery.

Keywords: 2D wavelet transform, Side Scan Sonar Image, de-noising algorithm, Haar wavelet

1. Introduction

The basic principle of the sonar was the sound use to detect or find objects specifically in the sea (Jain & Makris, 2016). Side scan sonar (SSS) has been used in the survey for imaging the seabed. The SSS is a sonar development that able to observe and show the two-dimensional surface pictures by the counter of the sea floor, topography, and the target simultaneously. This instrument is able to distinguish the small particles of the seabed structure such as rocks, muds, sand, gravel, or basic types other waters (Lubis *et al.,* 2017; Lubis & Anurogo, 2017).

Frequency domain filtering assume that Fourier coefficients of original image are mainly concentrated in lower frequency so noise is suppressed by remove the higher frequency coefficients using a low pass filter. Theoretically, if only few coefficients of images are high magnitude and most coefficients are close to zero (the image is sparsely represented in the transform domain), the performance of transform domain de-noising methods would be better. But the sparsity of representation depends on both the transform and the original image's property. The great varieties in natural images makes impossible for any fixed transform to achieve good sparsity for all class of images.

For example, Two-Dimensional wavelet transform is effective in representing textures and smooth transitions of an image but would perform poorly for singularities such as image edges. The strength of the wavelet domain is that it sparsely represents classes of signals containing singularities and sharp transitions. So the de-noising has been a necessary process in the seabed identification using side scan sonar imagery. This paper also proposes the transformation of 255 image into gray scale image, binaryzation and normalization in the development of internet of things and image pre-process (Smith & Friedrichs, 2015). A 3D image processing method (Yin & Li, 2017) for the internet of things is put forward to provide an atomized monitoring system (Lewis & Rhoads, 2015) for the image information of crop pests on the basis of internet of things. The use of two-dimensional wavelet and wavelet packet technology can achieve the perfect compression and de-noising with liver image (Afonso & Scanches, 2015).

2. Wavelet Transform

In most of the applications of image processing, it is essential to analyze a digital signal. If the data will be transformed into any other domain then the structure and features of the signal may be better understood. There are several transforms available like Fourier transform, Hilbert transform, Wavelet transform, etc. The wavelet transform is better than Fourier transform because it gives frequency representation of raw signal at any given interval of time, but Fourier transform gives only the frequency-amplitude representation of the raw signal but the time information is lost (Sukanya & Preethi, 2013). So we cannot use the Fourier transform where we need time as well as frequency information at the same time. Wavelets are mathematical functions that cut up data into different frequency components. The fundamental idea behind wavelets is to analyze the signal at different scales or resolutions, which is called multiresolution. The most important feature of wavelet transform is it allows multiresolution decomposition.

3. Haar Transform

Haar functions have been used from 1910 when they were introduced by the Hungarian mathematician Alfred Haar (Tedmori & Al-Najdawi, 2014). Haar wavelet is discontinuous, and resembles a step function. It represents the same wavelet as Daubechies db1, db2, and db3. Haar used these functions to give an example of an orthonormal system for the space of square-integrable function on the unit interval 0, 1 (Fig1).

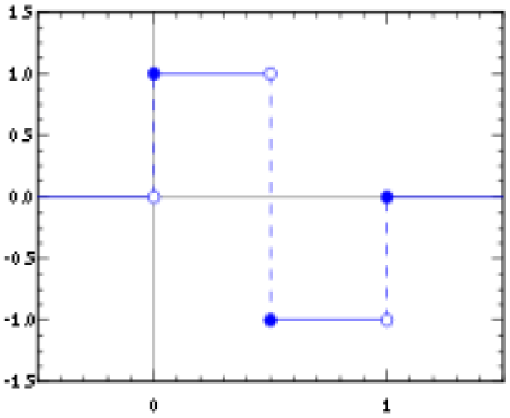

Fig 1. Haar wavelet

This process is repeated recursively, pairing up the sums to provide the next scale, finally resulting in differences and one final sum. For an input represented by a list of numbers, the Haar wavelet transform may be considered to simply pair up input values, storing the difference and passing the sum. The Haar Wavelet Transformation is a simple form of compression which involves averaging and differencing terms, storing detail coefficients, eliminating data, and reconstructing the matrix such that the resulting matrix is similar to the initial matrix (Navneet & Kaur, 2014). A Haar wavelet is the simplest type of wavelet. In discrete form, Haar wavelets are related to a mathematical operation called the Haar transform. The Haar transform serves as a prototype for all other wavelet transforms (Lubis *et al.,* 2016). Like all wavelet transforms, the Haar transform decomposes a discrete signal into two sub-signals of half its length. One sub-signal is a running average or trend; the other subsignal is a running difference or fluctuation.

4. Methodology

Following steps are performed for compression :

a) Load the image which is compressed.
b) Applying the transform-The compression algorithm starts by transforming the image from data space to wavelet space. This is done on several levels.
c) Chossing the threshold- neglect all the wavelet coefficients that fall below a certain threshold. We select our threshold in such a way as to preserve a certain percent of the total coefficients - this is known as ‖quantile‖ thresholding.
d) Perform compression at different transform

5. Result

In this paper, we compared Haar wavelet of Discrete wavelet transform (DWT). The quality of a compression method could be measured by the traditional distortion measures such as Mean square error (MSE) and energy retained (ER). We compared the performance of these transforms on image sss.jpg (255x255) (Fig 2). We actually use side scan sonar image into the Wavelet 2-D graphical tool except with all the details involved in multilevel image decomposition in command line in order to more easily display it. The results tell what percentage of the wavelet coefficients was set to zero and what percentage of the image's energy was preserved in the compression process. Here even though the compressed image is constructed from only about half as many nonzero wavelet coefficients as the original, there is almost no detectable deterioration in the image quality (Fig 3). De-Noised image 2D using Haar wavelet, v1,v2, and v3 has histogram of residual 0-0.1 and DI -15-20 (Fig 4).

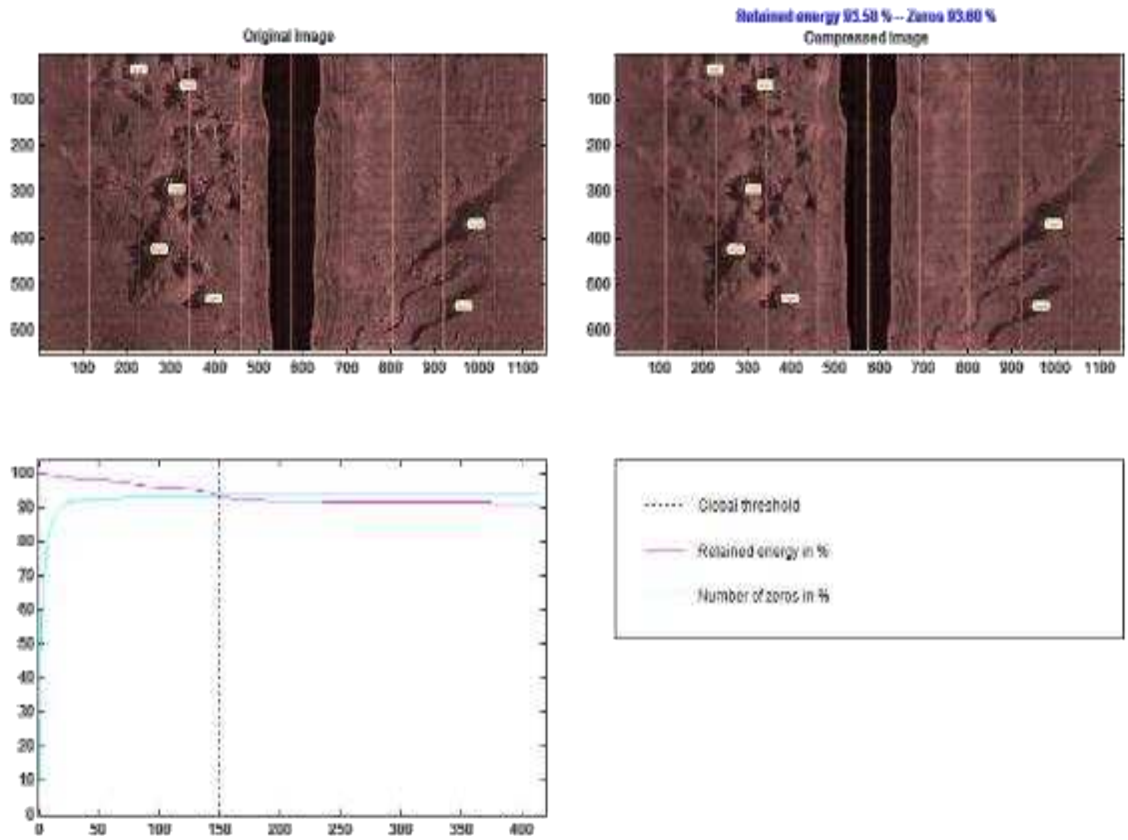

Fig 2. Graph shows the retained energy 93.8 % and zeros in 93.60 % Haar Wavelet

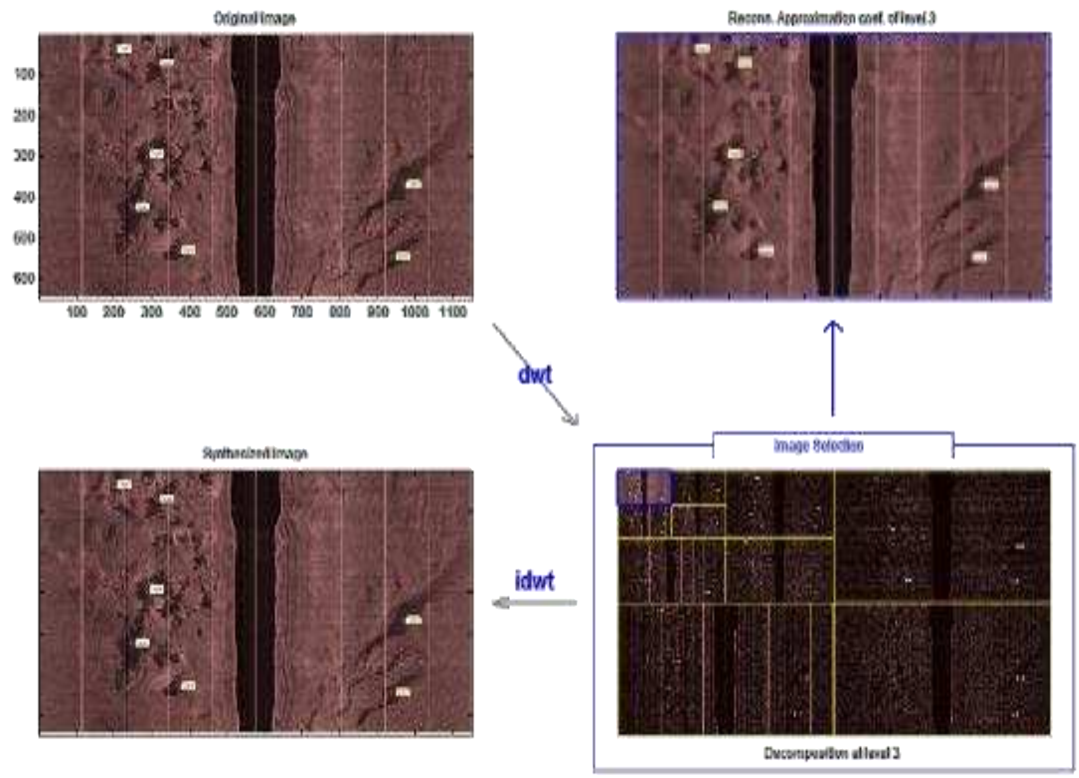

Fig 3. Decomposition at level 3 using Haar wavelet

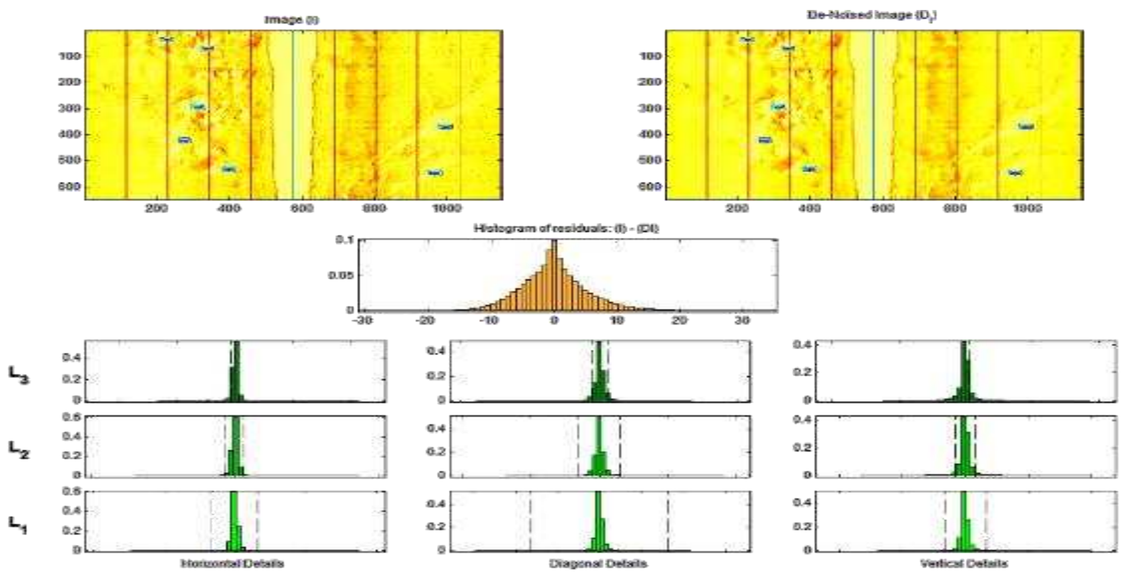

Fig 4. De-Noised image 2D using Haar wavelet

6. Conclusion

Compression of image is an important field in Digital signal processing. In this paper, comparison of various transforms based image compression method is described. In lossy compression the information is loss, so we not restore all the information. Ideally, during compression the no of zeros and the energy retention will be as high as possible. In Haar wavelet retained energy is 93.8 %, so from the results, it has been concluded that Haar wavelet transform shows the best results in terms of Energy from De-noised Image processing with side scan sonar imagery. Usually this information is the same, but in some cases, edge effects may cause the original image to be cropped slightly. To see the exact statistics, we can use the command line functions to get the desired image and then apply the desired MATLAB statistical function.

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