IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
December 2020 Vol.:17, Issue:2
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A Method of Digital Signal Processing by Wavelet Transforms

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Hong Wang*, Yanyan Wang

College of Science,
Zhongyuan University of Technology, Zhengzhou,
450007, China.

Submitted: 07 November 2020
Revised: 27 November 2020
Accepted: 17 December 2020

HUMAN JOURNALS
www.ijsrm.humanjournals.com

Keywords: Radar Digital Signal Processing; Wavelet Transforms; Echo-Signals; Non-Stationary

ABSTRACT

An effective method of radar digital signal processing based on wavelet transformation is introduced. Because the Fourier transform is a global transformation, the representation of the signal is either completely in the time domain or completely in the frequency domain. For time-varying non-stationary signals, it is often desirable to obtain the change of signal spectrum with time, that is, the time-frequency representation of the signal. Wavelet analysis is a signal processing method suitable for non-stationary signals. This chapter studies radar signal feature extraction based on wavelet analysis. In this dissertation, the methods have been simulated and tested with feasible results that have greater theoretical significance and actual applied value in regarded to radar signal processing and target identifying in our aerial defense weapon system.

1 INTRODUCTION

In order to complete the radar digital signal detection and information extraction function of the implementation means. The echo of the object is a weak high-frequency signal, which is transformed into an analog signal with a certain strength after the processing of frequency conversion, amplification and filtering (continuous in time and arbitrary real value in amplitude). Digital processing requires the use of analog-to-digital converters to convert analog signals into digital signals (discrete in time and layered in amplitude), and then carry out various operations and processing. Early radar signal processing was almost entirely analog [1-3]. In the 1950s there were radar systems that used computers for signal processing. This is the beginning of radar digital signal processing, function is limited to automatic detection. Radar signal processing is an important part of radar system. The signal processing is to eliminate unnecessary clutter, by the target signal, and extract the target information. In this paper, we discuss the content include radar signal processing of several major parts: orthogonal sampling pulse compression Multi-threading/ Multithreaded debugging (MT/MTD) and constant false alarm detection. Orthogonal sampling is the first step in signal processing, provides high quality data for the subsequent processing water for the task [4-7]. Sampling is a primary issue to consider the speed and precision, sampling system cause the distortion should be limited in the subsequent signal processing tasks required by the error range, the direct intermediate frequency digital quadrature sampling is the main technology of modern radar One. After amplification, the frequency and intermediate frequency filtering adopts high performance Analog to Digital Converter (ADC) direct intermediate frequency sampling, utilized the digital orthogonal mixing and digital filtering technology, and use the latch drive circuit F work F0 memory with Programmable ASIC devices circuit, can generate a reliable high precision quadrature sampling system. This paper focuses on the analysis and the implementation of quadrature interpolation algorithm. Pulse compression technology has been widely applied in modern radar system [8-10]. Keep both narrow pulse radar pulse compression radar high range resolution, and can obtain wide pulse radar detection ability, and strong anti-jamming capability. Now, using the waveform of pulse compression radar is developed from a single linear frequency modulation to the time and frequency coding modulation, in as far as possible not to increase the machine under the condition of the complexity of radar performance improvement. Based on the linear frequency modulation signal as an example this paper introduces the commonly used method of pulse pressure. Clutter suppression is the need to have one of the important function of radar. Dynamic target designation and detection is by echo doppler frequency shift is different to distinguish targets and fixed target, through the reasonable design of filter (set), can separate the target signal and noise. A complete system of clutter suppression is MT industry/MTD clutter map constant false alarm rate (CFAR) detection technologies such as an integrated application, and achieve from the clutter and noise environment detection task. This article used in radar detection technology was analyzed. Although radar intermediate-frequency signal frequency is higher, but the useful signal spectrum is often a narrow band spectrum, so you can use a certain rate of undersampling Ensure the useful signal spectrum does not produce mixed up, so as to get the correct Q signals [11]. Orthogonal coherent filtering is to use the space frequency spectrum overlapping principle, using spectrum mixed idea reflected many times, the original carrier frequency location map to the location of the zero frequency, so as to realize intermediate frequency to zero intermediate frequency down-conversion. To achieve this goal, the Analog-to-digital conversion (AD) sampling rate and intermediate frequency must have a strict relation, and at the same time in order to satisfy the spectrum interval requirements. Ask people zb 6, B for the signal bandwidth. General in order to reduce the difficulty of the quadrature interpolation filter design, choose 4 B, the sampling rate is four times the signal bandwidth. When using the principle after AD conversion, digital quadrature coherent filtering is then required. As the direct intermediate frequency signal for several important methods of quadrature coherent detection are: low pass filtering method of Digital Product Detection (DPD) Hilbert transform method of Bessel interpolation method. The following is our most basic method to realize the low pass filter method for explanation and simulation analysis [3]. The low pass filtering method is mainly through the narrowband intermediate frequency signal of mixing after orthogonal transformation, then carries on the symmetry of the spectrum of a low-pass filter to eliminate the negative frequency components (the equivalent of mirror frequency), and then to send a sample processing, with two way finally complete show real orthogonal signal Full information about the signal.

2 Discrete wavelet transforms theory

Among all the possible choices, the Gaussian and the Mexican Hat wavelets have yielded the best results. The Gaussian function is not actually a wavelet, as it is not a band-pass function; on the contrary, it performs a lowpass filtering. However, it is often employed in the field of signal analysis. The Mexican Hat wavelet is the second derivative of a Gaussian:

$$\psi(x) = K(1-x^2)\exp(-x^2/2) \quad (1)$$

With K is a factor necessary to normalize the wavelet energy.

Discrete wavelet transform is defined as

$$\begin{aligned} A_j f &= \sum_{n\in z} h(n-2k)A_{j-1}f \quad j=1,2,......,J \\ D_j f &= \sum_{n\in z} g(n-2k)A_{j-1}f \end{aligned} \quad (2)$$

Where $h(n), g(n)$ is low-pass and high-pass filters,

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Inverse wavelet transform is defined as

$$A_{j-1}f = \sum_{n\in z} h(k-2n)A_j f + \sum_{n\in z} g(k-2n)D_j f \quad (3)$$

In order to select the best basis, Coifman and Wickerhauser introduced the concept of information cost function that is used as a measure to search for its minimum over all the wavelet packet bases. The most used information cost function is Shannon entropy. For a discrete signal X of unit energy, the Shannon entropy of the decomposition coefficient sequence $X_{n,j} = \{x_{n,j}^k\}$ of the nth node at level j of the wavelet packet tree is computed by [4,5].

$$M(X_{n,j}) = -\sum_k (x_{n,j}^k)^2 \log(x_{n,j}^k)^2 \quad (4)$$

Where $(x_{n,j}^k)^2 \log(x_{n,j}^k)^2$ is taken as 0 if $x_{n,j}^k = 0$. $M(X_{n,j})$ reflects the degree of energy concentration of the coefficient sequence. It is large if the elements of the sequence are roughly the same and small if all but a few elements are negligible. Fig.1 is the diagram of wavelet transformation.

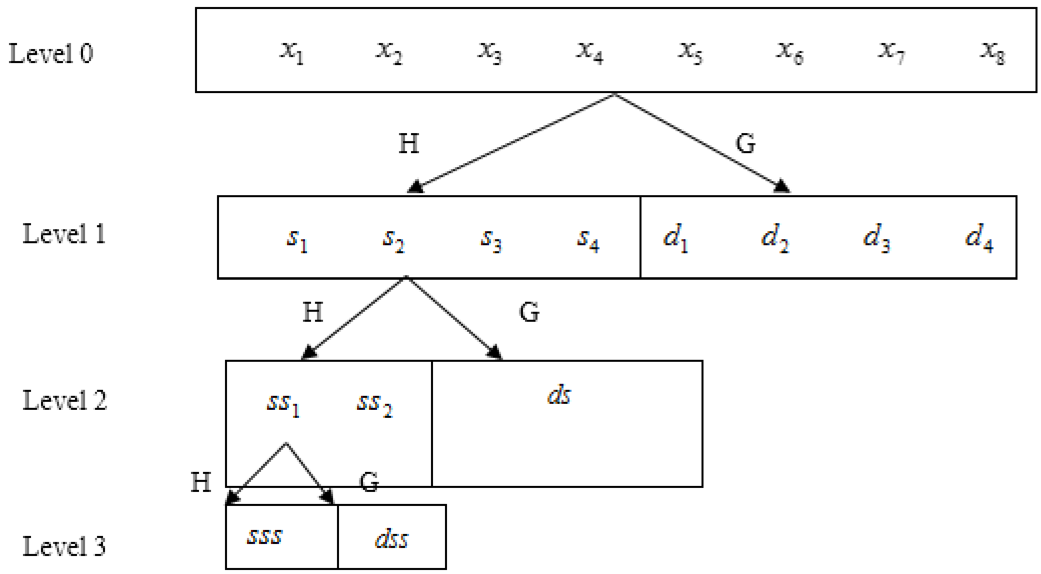

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Figure No. 1: Wavelet packet tree of R^8 space

The Mallat algorithm is a fast, linear operation that operates on a data vector whose length is an integer power of two, transforming it into a numerically different vector of the same length. Many wavelet families are available. However only orthogonal wavelets (such as Haar, Daubechies, Coifet, and Symmlet wavelets) allow for perfect reconstruction of a signal by inverse discrete wavelet transform, i.e. the inverse transform is simply the transpose of the transform. In this study, we will restrict ourselves to wavelet filters in a class discovered by Daubechies. Selection of this mother wavelet was not optimized in any way. Additional performance gains are likely to be achieved if one optimizes the mother wavelet selection. In particular, matching characteristics of the mother wavelet with expected characteristics of the signal usually yields improved performance.

As our application involves both pattern detection and image coding for transmission, some care must be taken in choosing a technique able to ease both tasks. Our main requirements are:

1) Availability of fast algorithms.

2) Capability of performing joint compression and detection in the transformed domain and transmission of the transformed instead of the image coefficients.

3) Capability of reconstructing a full detail (and not only an edge map) image.

3 Wavelet transforms for radar digital signal processing

This method is intended to localize target in space. This implies finding the location and time of the radar target in addition to its existence. The wavelet coefficients tend to show irregularity near the crack. This property enables one to find the location of radar target in space. The following are applications of these methods. The main idea behind the use of wavelets for radar target detecting purposes is based on the fact that the presence of discontinuities radar target echo. Often these discontinuities cannot be observed from the examination of the radar target echo, but they are detectable from the distribution of the wavelet coefficients obtained by the detail signals form the discrete wavelet transformation (DWT). The following procedure is proposed to detect radar echo by DWT as follows:

- Measure (or for numerical simulations, calculate) the radar signals.
- Using the measured signal, compute its wavelet coefficients from the detail signals associated with the discrete transforms.
- Plot and examine the wavelet coefficients for the detail signals in the case of the DWT.

Provided that a suitable wavelet is selected for the analysis, any signal discontinuity will be detected by the distribution of coefficients on the wavelet coefficients plot. In order to observe the signal discontinuities, it is recommended to perform a low-scale analysis for a low-level analysis for the DWT.

4 EXPERIMENTAL RESULTS

Fig.2 shows that the aircraft radar echo. First, the echo is quickly decomposed by the Mallat algorithm. The wavelet coefficient is calculated, as shown in Fig.3. Second, we investigate the varying features of wavelet coefficients of radar target signals. The wavelet coefficients are recessed through a threshold, and then the target signals are reconstructed and the radar target is recognized.

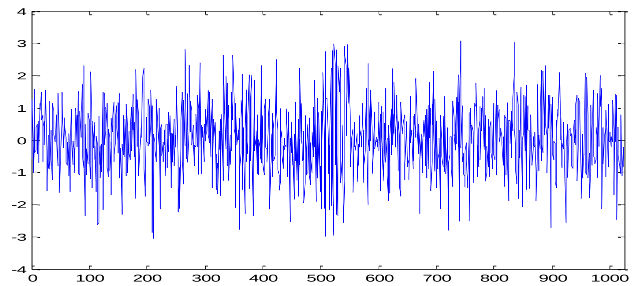

Figure No. 2: The original aircraft radar echo

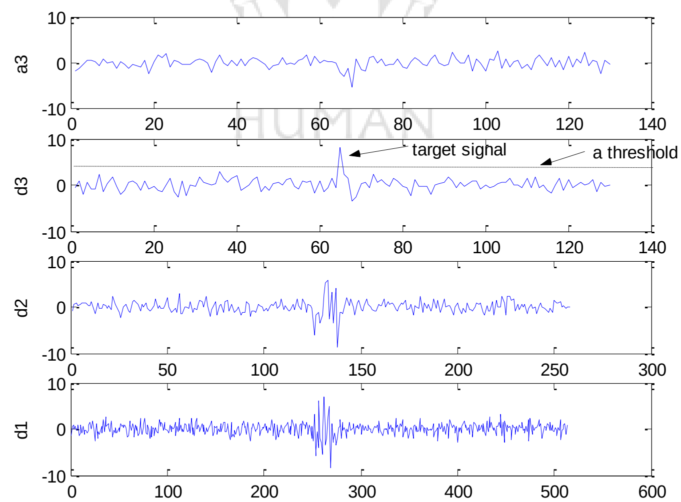

Figure No. 3: The wavelet coefficients of aircraft radar echo

From Fig.3, it is found that the wavelet transform can determine the frequency information of the signal at a certain time. Because the frequency of a signal is inversely proportional to its period length, the time interval for high frequency information should be relatively small to give better accuracy. For low spectrum information, the time interval should be relatively wide to give complete information. Because wavelet analysis can use gradually fine sampling step in time or space domain for high frequency components, it can use flexible time-frequency window to conduct fine analysis of signals.

5. CONCLUSION

Unlike other radar signal processing techniques, wavelet-based methods can be applied not only to structural members but also to full structures. In addition, the target can be detected using the radar signal. This is a very useful feature of the method since it is much easier and more inexpensive to measure the static response compared to the dynamic signal. Another fact that makes the wavelet-based methodology easy to implement in practice is that it can be used for radar echo only. More importantly, experimental studies are urgently needed to validate the results obtained from the numerical simulations. Real signals obtained by radar target echo should be analyzed by the wavelet transform in order to demonstrate the reliability and robustness of the technique in the presence of noise and the unavoidable uncertainties associated with experimental procedures.

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REFERENCES

[1] Al-Hiary, H., Bani-Ahmad, S., Reyalat, M. *et al*. Fast and Accurate Detection and Classification of Plant Diseases. International Journal of Computer Applications 2011,17(1):31-38.

[2] Revathi, P., Revathi, R.. Knowledge Discovery in Diagnose of Crop Diseases Using Machine Learning Techniques. International Journal of Engineering Science and Technology, 2011, 3(9):7187-7191.

[3] Ananthi, S., Vishnu Varthini, S.. Detection and classification of plant leaf diseases. International Journal of Research in Engineering and Applied Sciences, 2012,2(2): 763-773.

[4] Mohamad Faizal Ab Jabal, Suhardi Hamid, Salehuddin Shuib and Illiasaak Ahmad. Leaf features extraction and recognition approaches to classify plant. Journal of Computer Science, 2013, 9 (10): 1295-1304.

[5] Kadir A., L.E. Nugroho, A. Susanto and P.I. Santosa. A comparative experiment of several shape methods in recognizing plants. International Journal of Computer Science, 2011,3: 256-263.

[6] Al-Bashish D., M. Braik, S. Bani-Ahmad. Detection and classification of leaf diseases using K means-based segmentation and neural-networks-based classification. Journal of information technology, 2011,10: 267-275.

[7] Bauer, S. D., F. Korc, W. Forstner. The potential of automatic methods of classification to identify leaf diseases from multispectral images. Precision Agriculture, 2011,12: 361-377.

[8] Qing,H.H., Ma,B.X., Qu,D.Y., et al.Cotton Pests and Diseases Detection based on Image Processing. Telecommunication, Computing, Electronics and Control,2013, 11(6):3445-3450.

[9] Wang X D, Wang H M, Dang A R. Research on large-scale dynamic monitoring of landuse with RS, GPS and GIS. Igarss 2000: IEEE 2000 International Geoscience and Remote Sensing Symposium, Vol I-Vi, Proceedings. New York: IEEE, 2000: 2134-2136.

[10] Atzori L, Iera A, Morabito G. The internet of things: A survey. Computer Networks, 2010, 54(15):

2787－2805.
[11] Liang Y., Lu X.S., Zhang D.G., *et al.* Study on the framework system of digital agriculture[J]. Chinese Geographical Science, 2003, 13(1): 15－19.