There are several advantages of the wavelet transform. Compared to Fourier series, wavelet series converge uniformly for all continuous functions, while Fourier series do not. They are also adjustable and adaptable. Discrete analysis ensures space-saving coding and is sufficient for exact reconstruction. Many years back, wavelet transform have been developed to solve frequency-dependent problems in many areas. This is because the wavelet transform has many advantages over the traditional Fourier transform. One of the advantages of wavelet transform has over the Fourier transform is its ability to identify the locations containing observed frequency content. It is able to localize the information in the time-frequency plane. Even the Fourier transform can extract pure frequencies from the signal; it cannot indicate the locations of the extracted frequencies.

Power disturbances can be classified as stationary and non-stationary signals. Fourier transform is not suitable for analyzing non-stationary signals. To correct this deficiency, here comes the Short-Time Fourier Transform which was developed to extract time-frequency information. Yet, the disadvantage is that the size for the time-window is fixed for all frequencies. On the contrary, wavelet analysis represents a windowing technique with variable-sized of regions. Plus, there exists the MRA algorithm, which decomposes original signal into several other signals with different level of resolution. Wavelet decomposes and reconstructs functions actively using the MRA. The DWT with the MRA easily converts the function to its coefficients because of the reversibility property. It uses analyzing wavelet functions, which are localized in both time and frequency to detect a small change in the input signals.

CHAPTER 3

DISCRETE WAVELET TRANSFORM AND MULTIRESOLUTION ANALYSIS

3.1 Introduction

Before Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT) were developed, Fourier Transform approach was widely used to overcome signal processing problems. Many mathematical tools were developed under Fourier Transform approach and the most significant is Short Time Fourier transform (STFT). The CWT was developed as an alternative approach to the STFT to overcome the resolution problem. The wavelet analysis is done in a similar way to the STFT analysis. However, there are two main differences between the STFT and the CWT:

1. The Fourier transforms of the windowed signals are not taken, and therefore single peak will be seen corresponding to a sinusoid where negative frequencies are not computed.

2. The width of the window is changed as the transform is computed for every single spectral component, which is probably the most significant characteristic of the wavelet transform.

CWT is used to divide a continuous-time function into wavelets. Unlike Fourier transform, the CWT possesses the ability to construct a time-frequency representation of a signal that offers very good time and frequency localization. Although the discretized continuous wavelet transform enables the computation of the continuous wavelet transform by computers, it is not a true discrete transform. In addition, CWT provides highly redundant information as far as the reconstruction of the signal is concerned. This redundancy, on the other hand, requires a significant amount of computation time and resources.

On the other hand, DWT provides sufficient information both for analysis and synthesis of the original signal, with a significant reduction in the computation time. The DWT is considerably easier to implement when compared to the CWT. Generally, an approximation to DWT is used for data compression if signal is already sampled, and the CWT for signal analysis. Thus, DWT approximation is commonly used in engineering and computer science, and the CWT in scientific research.

3.2 The discrete wavelet transform

In the year of 1976, DWT was found when Croiser, Esteban, and Galand devised a technique to decompose discrete time signals. Crochiere, Weber, and Flanagan did a similar work on coding of speech signals in the same year. They named their analysis scheme as subband coding. In 1983, Burt defined a technique very similar to subband coding and named it pyramidal coding which is also known as multiresolution analysis (MRA).

Although the DWT is merely one more tool added to the toolbox of digital signal processing, it is a very important concept for data compression. A wavelet, in the sense of the DWT is an orthogonal function which can be applied to a finite group of data. Functionally, it is very much like the Discrete Fourier Transform, in that the transforming function is orthogonal, a signal passed twice through the transformation is unchanged, and the input signal is assumed to be a set of discrete-time samples. Both

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