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Performance Analysis of orthogonal and Biorthogonal wavelets for Edge detection of X-ray Images

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Abstract

The X-ray images are extensively used by the medical practitioners to detect the minute fractures of bone images as they are painless and economical compared to other image modalities. The minute fractures cannot be identified with nacked eye. So the X-ray images are to be processed for detecting the minute fractures. The orthogonal wavelet transforms like Haar, daubechies etc can be used as edge detector, but a lot of false edge information will be extracted. Edge detection of X-ray images using Multiresolution Analysis(MRA) based biorthogonal wavelets is more preferable when compared with orthogonal wavelets because of more flexibility.. Therefore biorthogonal wavelet transforms like bior1.3,bior2.4 are applied to detect the edges and are compared for edge feature extraction. Among all the methods, biorthogonal wavelet bior1.3 performs well in detecting the edges with better quality. The various performance metrics like Ratio of Edge pixels to size of image (REPS), peak signal to noise ratio (PSNR) and computation time are compared for various wavelets for edge detection.

keywords:Edge detection; Multi-resolution analysis; orthogonal wavelet; biorthoognal Wavelet transform

1. INTRODUCTION

Edge detection of X-ray images delivers details about fracture in bone and plays an important role in patient diagnosis for doctors. Bone edge detection in medical images is a crucial step in image guided surgery. Edge feature extraction of X-ray bone image is very useful for the medical practitioners as it provides important information for diagnosis which in turn enable them to give better treatment decisions to the patients. Presently digital images are increasingly used by medical practitioners for disease diagnosis The images are produced by several medical equipments like MRI, CT, ultrasound and X-ray. Out of these, X-ray is the oldest and frequently used devices, as they are painless and economical. The X-ray images are used during various stages of treatment which include fracture diagnosis and treatment. Edge feature extraction deals with extracting or detecting the edge of an image. It is the most common approach for detecting meaningful discontinuities in the gray level [11]. It is one of basal

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contents in the image processing and analysis, and also is a kind of issues which are unable to be resolved completely so far [3]. When image is acquired, the factors such as projection, mix, and noise are produced. These factors bring on image feature's blur and distortion, consequently it is very difficult to extract image feature. Moreover, due to such factors it is also difficult to detect edge [9].

The classical derivative operators such as Roberts, Prewitt,sobel, Laplacian of Gaussian[4][6] can be used. But a lot of false edge information will be extracted. They are also sensitive to noise. These operators are applied on pixel by pixel basis. They are slow in operation. The high frequency components of an image includes both edges and noise. So detecting the edge is not an easy task. Therefore an efficient technique based on wavelet transform is used to detect the edges. This is because wavelet transform has the advantage of detecting edges using different scales. The orthogonal wavelet transforms like Haar, daubechies, symlets can be used to detect the edges of an image. But a lot of false edge information will be extracted. They are also sensitive to noise. Depending upon the properties of the wavelet, the quality of the edge results would be obtained [8].As there are different properties of the wavelet such as orthogonality, symmetry and vanishing moments which can be varied, therefore qualities of detected edge are different. The biorthogonal wavelet is more advantages compared to orthogonal wavelet. An important property of human visual system is that people are more tolerant of symmetric errors than asymmetric ones. Therefore, it is desirable that the wavelet and scaling functions are symmetric. Unfortunately, the properties of orthogonality and symmetry conflict each other in the design of compactly supported wavelet. Owing to this analysis it is necessary to use symmetric biorthogonal wavelets [10].

2. Wavelet Transform Theory

Frequency domain analysis using fourier transform is extremely useful for analysing the signal because the signal's frequency content is very important for understanding the nature of signal and the noise that contaminates it. The only drawback is, loss of time information. When looking at a fourier transform of signal, it is impossible to tell when a particular event took place. So to overcome this drawback, the same transform was adapted to analyse only a small window of the signal at a time. This technique is known as short time fourier transform which maps a signal into a two dimensional function of time and frequency to get the localized point information but the only drawback is that, the window size is same for all frequencies. Many signals require more flexible approach that is flexible window size. This technique is known as wavelet transform. A wavelet is a "small wave", which has its energy concentrated in time to give a tool for the analysis of transient, non-stationary, or time-varying phenomena about analyzing signal with short duration finite energy functions [1]. They transform the signal under investigation into another representation which presents the signal in a more useful form. It still has the oscillating wave-like characteristic but also has the ability to allow simultaneous time and frequency analysis with a flexible mathematical foundation. Wavelet transform is widely used in image processing. Wavelet transform of a signal means to describe the signal with a family of functions. In two-dimensional images, the intensity of edges can be enhanced in each one-dimensional image. If the window of the images is convolved in the x direction over an image, a peak will result at positions where an edge is aligned with the y direction. This operation is approximately like taking the first derivative of the image intensity function with respect to x or y.

2.1. Orthogonal Wavelets

The discrete wavelet transform have two functions i.e scaling function and wavelet function. The wavelet functions are derived from the scaling function. The scaling function is orthogonal to wavelet function and hence they are called orthogonal wavelets. The support interval of wavelet is the range of the interval over which the scaling and wavelet function is defined. These are finite support and compact wavelets which are more popular due to their relations to multiresolution filter banks. Orthogonal wavelet systems decompose signals into well-behaved orthogonal signal spaces. However, the analysis and synthesis filters are not symmetric [8].There are different types of orthogonal wavelets such as Haar, daubechies, coiflets, etc. These are compactly supported orthogonal wavelets thus making discrete wavelet analysis practicable.