Seismic Signal Processing and Image Analysis

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Summary

Mathematical morphology has its applications in both optical and acoustic image analysis and is useful in image cleaning, image enhancement, feature selection and extraction, quantitative analysis, etc. Morphology has the capabilities of performing quantitative analysis of images using morphological operation. Partial differential equation(PDE) is employed for Anisotropic Diffusion filtering techniques where the filtering is guided by the local structures in the image. seismic processing image for an example. Another example is fingerprint enhancement where smooth the image along the direction of the texture in the image(adaptive filtering for image analysis), while the edges are sharpened in the other direction, giving a high contrast image of the fingerprint. Image analysis follows three steps: image processing (image-> image), Analysis(image- attributes), Understanding and interpretation(attributes->attributes).3D seismic image filtering, the method of 3D anisotropic diffusion filtering is applied and the relationship between the eigenvalues of structure tensor and the stratum structure has been analyzed in detail. By using structure tensor, extracted the local structure of 3D seismic image, and using the improved coherent enhancement diffusion method, designed eigenvalues of diffusion tensor ,and constructed the diffusion tensor to control the diffusion rate of three main orientation. Extracting fault, unconformity, and horizon surfaces from a seismic image is useful for interpretation of geologic structures and stratigraphic features. Although interpretation of these surfaces has been automated to some extent by others, significant manual effort is still required for extracting each type of these geologic surfaces. automatically extract all the fault, unconformity, and horizon surfaces from a 3D seismic image. To a large degree, just involve image processing or array processing which is achieved by efficiently solving partial differential equations.Geophysical interpretation is closely related to geologic interpretation, i.e., the task of inferring from a description of a region the sequence of events which formed that region. The description of the region can be a diagram representing a cross-section of the region, which comes e.g. from the geophysical interpretation of a seismic cross-section, together with an identification of the rock types. Geologic interpretation is not static. It attempts to reconstruct the sequence of events which occurred, i.e., it converts the signal data from a spatial domain to the temporal domain of geologic processes.Seismic interpretation is a difficult task, because the seismic data are usually fuzzy and noisy. Furthermore, it is heavily based on the available geological and geophysical knowledge of the region and on the expertise of the interpreter. The most common approaches are the following:-Seismic pattern recognition;Seismic image processing; Graphics-visualization(GPU graphic processing unit-sobel filter/gradient filter);.Geophysical and geologic expert systems-cognitive geoscience.

Introduction

Partial differential equations (PDE) is employed for image denoising smooth out the high frequency oscillation while keeping the edges in the high noisy level images. The presence of noise in images is unavoidable.It may be formed by image formation process, image recording,image transmission etc.These random distortions make it difficult to perform any required image processing task. The purpose of image denoising is to preserve edges as far as possible while removing noise, making the resulting images approximate the ideal image. The advantages of both second order and fourth order partial differential equations are utilized here.The image is denoised using second order partial differential equations , fourth order partial differential equations and the combination of both. Images are a form of data that carries information. As with any other form of data, the information within each picture can be affected by errors or noise. The source of errors varies from image to image, and along with the effects of signal transmission. These errors are responsible for the blurred and deteriorated images. Image denoising techniques improve the quality of an image as perceived by a human. The aim of image denoising is to improve the interpretability of information in images for human viewers, or to provide better input for other automated image processing techniques. Noise mixed with image is harmful for image processing. Image denoising play an important role in Image processing task. Remove the noise when the edges are in the preserving state is called image denoising. In the image processing task it is a major and most common problem. If we want a very high quality resolution images as the outcome then we must consider the noise parameters for reducing those parameters to achieve better results. The main purpose or the aim of image denoising is to recover the main image from the noisy image. Second order partial differential equations is effective for removing noise and edge preservation. Gradient of the image is utilized here. An image gradient is a directional change in the intensity in an image.Image gradients can be used to extract information from images. Gradient images are created from the original image for this purpose. PDE is employed for Anisotropic Diffusion filtering techniques where the filtering is guided by the local structures in the image. To reduce the blocky effect, fourth order partial differential equations have been introduced. Fourth order partial differential equations can dampen noise much faster than second order partial differential equations. smooth the image along the direction of the texture in the image(adaptive filtering for image analysis), while the edges are sharpened in the other direction, giving a high contrast image of the fingerprint. Kuwahara filter is an adaptive, edge preserving smoothing filter.The Kuwahara filter is a non-linear smoothing filter used in image processing for adaptive noise reduction. Most filters that are used for image smoothing are linear low pass filter that effectively reduce noise but also blur out the edges. However the Kuwahara filter is able to apply smoothing on the image while preserving the edges.Sobel filter is used for edge detection.Texture Analysis of Seismic Images:Texture information of the seismic images is directly related to the stratigraphic information. Chaotic or reflection-free or stratified patterns are simple texture patterns. Some techniques that have been proposed for seismic texture analysis will be presented briefly. Template matching assumes that a seismic pattern can be represented by a set of matrices called templates. Each seismic region corresponds to a seismic pattern, which is described by a set of templates. These templates can be selected by an expert from an already interpreted seismic section. Another matrix (having equal dimensions with the template), contains the reflection coefficients around a pixel of the seismic image . Directional filtering is a technique for the decomposition of an image to regions having similar texture directionality. Directional information about texture is contained in the power spectrum of a seismic image. Power concentrations on lines in the power spectrum of an image correspond to texture having perpendicular orientation to the spectral lines. Therefore, directional filters can be used for seismic texture segmentation. Weierstrass' approximation theorem; Weierstrass function, wachspress patches applications in seismic imaging geophysical migration mapping. Seismic Pattern Recognition:Pattern recognition has been perhaps, the first approach to automate certain tasks of geophysical interpretation (e.g. horizon picking, remote correlation, recognition of the nature and boundaries of an oil or gas reservoir). Horizon picking is the first task of geophysical interpretation which took advantage of pattern recognition techniques. The reason is that horizon picking is the first and fairly simple step in geophysical interpretation. A model of seismic reflections is usually needed for horizon picking. Seismic reflections are ideally quite similar to Ricker wavelets . Therefore, they can be modeled by a set of parameters which take into account their spectrum and their character that may exist in their arches.Syntactic methods can also be used for reflection modeling . A syntactic pattern recognition approach that uses structural information of the wavelet to classify Ricker wavelets and syntactic pattern recognition employing Hough transform.Pattern recognition with wavelet transform: It contains analysis and detection of singularities with wavelets; wavelet descriptors for shapes of the objects; invariant representation of patterns; texture analysis and classification; image indexing and retrieval; classification and clustering; face recognition using wavelet transform and wavelet-based image fusion,etc. Seismic Image Processing:Digital image processing techniques can be used for the processing of seismic images . There are two tasks of geophysical interpretation where digital image processing techniques can be employed: horizon picking;texture analysis of seismic images. Horizon Picking: The simplest approach to horizon picking is to consider horizons as sequences of local extrema of reflection intensity in the seismic image. By this way, horizon picking can be made by contour following techniques based on local decisions , or by the use of edge detector operators (e.g.,theLaplacian operator or edge detectors based on nonlinear filters . More complicated techniques for horizon picking are performed by using neighborhood information based on Markovian image models and dynamic programming. An edge detector is applied to the seismic image. The local image edges (edge elements) are considered to be parts of seismic horizons. Fractional Fourier Transform in Coherent Noise Attenuation Many seismic data processing techniques are based on different forms of time- frequency representation of signals. In the fractional Fourier transform (FRFT), signals can be represented in multiple domains including time and frequency. This gives an extra degree of freedom in data processing where the traditional Fourier transform (FT) is used. The main difference between the FT and FRFT comes from the difference of their transformation kernels. In FT, the kernel is complex sinusoids, whereas in the FRFT, it is a set of linear chirps. we took advantage of the multidomain property of the FRFT, and used it to separate spatially coherent hyperbolic events from linear events with higher level of accuracy. The fractional Fourier transform (FRFT) decomposes a signal into linear chirps. The limitation of the frequency domain representation arises from the fact that if both the signal and noise overlaps in the same frequency band, then their separation from each other becomes difficult if not impossible. In that scenario, the FRFT can be useful in signal separation and noise attenuation considering its ability to represent signals in any domain in the time-frequency plane within the range of the fractional order.There are a variety of algorithms for signal, image, surface, and data processing. The essential idea is the use of filters, such as linear, nonlinear, active, passive, low-pass, high-pass, Fourier, wavelet, Chebyshev, Gaussian, Kalman,Wiener, and conjugate filters.Fourier or spectral analysis is a classical technique for mode decomposition and remains to be a powerful tool in signal, image, and data processing . However, Fourier analysis is not suitable for studying data of non-stationary nature, and it may be difficult to choose a suitable window size to satisfy the conflicting requirements of localizing an event in time and resolving its frequency distribution. Wavelet transform is another popular technique for mode decomposition and shows a great power in analyzing unsteady and non-stationary data.Nonlinear partial differential equation (PDE) models are established approaches for image/signal processing, data analysis, and surface construction.The Fourier transform is a mathematical transformation that converts between two representations of a signal: The time-domain representation, or the value of the signal as a function of time. The frequency-domain representation, or the amplitude and phase of the signal as a function of frequency. A generalization of the Fourier transform is the fractional Fourier transform (FRFT). Continuous Fourier transform converts between the time- or spatial-domain representation of a signal and the frequency-domain representation of a signal. If we consider these two domains as orthogonal, then the continuous Fourier transform can be thought of as rotating a signal pie/2 radians from its time- or spatial-domain representation to its frequency domain representation. Generalizing this to any angle of rotation, the fractional Fourier transform can transform a function to intermediate domains between the time- or spatial domain and frequency domain..Fractional Fourier transform (FRFT) is a generalization of the Fourier transform, signal processing by emphasizing the practical digital realizations and applications of the FRFT.FRFT is closely related to other mathematical transforms, such as time–frequency and linear canonical transforms. FRFT is a valuable signal processing tool. FRFT offers many advantages over the traditional Fourier analysis.FRFT and The linear canonical transform(LCT) is a multiparameter integral transform and itrepresents a generalization of many mathematical transformations(e.g.,theFourier transform, FRFT,Fresneltransform) . It should be mentioned that the LCT is also called the affine Fourier transform, the generalized Fresnel transform, the Collins formula, the ABCD transform,orthe almost Fourierand almost Fresnel transformation. The transformation is useful in many practical applications such as optics,radar system analysis,filter design,phase retrieval,and pattern recognition Discrete Fractional Fourier Transform (DFRFT).DFRFT through sampling of FRFT A straight forward approach for obtaining the DFRFT is to sample the FRFT,since the sampling theorems for the FRFT of band limited and time-limited signals follow from those of the Shannon sampling theorem. However, the resultant discrete transform may lose many important properties(i.e.,unitarityandreversibility).In addition, the DFRFT obtained by direct sampling of the FRFT lacks closed-form properties and is not additive,meaning that its applications are very limited.FRFT present in other fields as well (e.g., fractal signal processing, pattern recognition, filtering). The main advantage is that the FRFT-based schemes increase processing accuracy. an adaptive filtering ,water marking,etc.The kernels of Fractional Fourier Transform corresponding to different values of alpha can be regarded as a wavelet family.

Another difficult image processing problem to efficiently solve given the traditional representation of an image is noise removal, since noise only makes sense in relation to neighboring pixels. One way to deal with noise that has a constant frequency throughout the image is the Fourier transform; however, for noise that varies in frequency in the image, the fractional Fourier transform must be used instead. Because the FRFT can transform a function into domains between the time- or spatial-domain and the frequency-domain, it naturally lends itself to simplifying applications where the signal's frequency varies over time or space. Of particular interest is the reduction of noise in images that is not constant throughout. The Fourier transform is excellent at removing noise that is constant through an image, simply by transforming the image into the frequency domain, removing the culprit frequencies, and then transforming back. The application of fractional Fourier transforms to image encryption has been further extended to color image encryption and the simultaneous encryption of two images, along with the usage of different transformations in the fractional Fourier domain Additionally, the fractional Fourier transform has been adapted to a variety of other fields, such as digital watermarking, image compression,etc.

Frequency Decomposition of Broadband Seismic Data: Challenges and Solutions **:**Frequency decomposition is a widely used method for identifying and discriminating different geological expressions in the seismic data by isolating seismic signals of particular frequency ranges. Several frequency decomposition techniques are available for the interpreter: each utilises different filtering methods, resulting in a variety in their resolution in time and frequency .The highest vertical resolution is achieved by a method based on a matching pursuit approach whereby Gabor wavelets at different frequencies and phase rotations are matched to a seismic trace in an iterative process according to the highest spectral energy.One of the drawbacks of the filter -based frequency decomposition techniques, such asFast Fourier Transform(FFT) or Wavelet Transform(WT), is that the vertical resolution of the original seismic data is not preserved due to vertical smearing (bleeding effect).High Definition Frequency Decomposition(HDFD) is a technique based on a modified matching pursuit algorithm which preserve seismic resolution.With the HDFD method,each seismic trace is decomposed into a number of individual waveletswhose sum equates to the original trace. After decomposition into wavelet responses, a trace can be reconstructed at any given frequency. The ability to decompose and recompose wavelets on a trace gives an end result with minimal vertical smearing allowing for the best vertical resolution.Spectral enhancement technique aims to balance the contribution of frequencies within the dataproducing a 'white spectrum',where all the frequencies contribute equally to the signal power. This leads to a better vertical resolution as a result of the increased bandwidth *.The* frequencies affect both the horizontal and vertical seismic resolution in the data; high frequency give high resolution while low frequency give low resolution. By using a frequency filter the lower frequencies are removed and the resolution is apparently improved.The resolution has not been improved, but the data masking the high frequencies has been removed. The drawback is that the amplitude is weakened as the total amount of data is reduced. The dominating frequency is normally used when calculating seismic resolution. This may lead to an underestimate as high frequencies in the data may improve the resolution.Frequency decomposition is now an accepted technique for identifying structural and stratigraphic variations within seismic reflectivity data. It is an extremely useful technique for identifying both channel systems and carbonate features especially when the expression is subtle and hard to interpret. SEISMIC UNIX,MATLAB,PYTHON are employed for seismic signal processing.

Seismic Resolution for subsurface imaging: The seismic method is limited in its ability to resolve or separate small features that are very close together in the subsurface. Geophysicists can do little about a rock's velocity, but they can change the wavelength by working hard to change the frequency. Reducing the wavelength by increasing the frequency helps to improve both temporal/vertical and spatial/horizontal resolution. Resolution thus comes in two flavours. The temporal resolution refers to the seismic method's ability to distinguish two close seismic events corresponding to different depth levels, and the spatial resolution is concerned with the ability to distinguish and recognise two laterally displaced features as two distinct adjacent events.The measurable seismic signals that they produce may show as separate, distinguishable signals when they are well separated – a condition we call 'resolved'. When the interfaces are close together, however, their effects on the seismic signals merge and it is difficult or maybe impossible to tell that two rather than just one interface is present – this condition we call 'unresolved'. The problem of resolution is to determine how to separate resolved from unresolved domains.

A much used definition of 'resolvable limit' is the Rayleigh limit of resolution: the bed thickness must be a quarter of the dominant wavelength. This resolution limit is in agreement with conventional wisdom for seismic data that are recorded in the presence of noise and the consequent broadening of the seismic wavelet during its subsurface journey. The dominant wavelength generally increases with depth because the velocity increases and the higher frequencies are more attenuated than lower frequencies.'Ghosts' Unwanted reflections from the free surface of the ocean continuously interfere in a constructive and destructive manner with the seismic wavefield propagated into the earth from a source array. The source wavefield reflected from the surface (the 'source ghost') is a time-delayed and opposite polarity version of the source wavefield propagated directly from the source array into the earth, and the two wavefields propagate together in a coupled manner. The net effect is that the frequency bandwidth propagated into the earth contains significant notches at periodic frequencies, and the notch frequencies are a function of both source depth and emission angle (measured with respect to vertical).Similarly, the receivers (along each streamer) record two versions of the seismic wavefield scattered back from the earth, coupled together and interfering in a continuously constructive and destructive manner. The wavefield reflected downwards from the free-surface of the ocean (the 'receiver ghost') is referred to as the 'down-going' wavefield, and is a time-delayed and opposite polarity version of the 'upgoing' wavefield. The wavefield recorded with conventional hydrophone-only streamers is a scalar measurement of pressure; the 'total pressure', which is the sum of the up-going and downgoing pressure wavefields. The recorded total pressure wavefield contains significant notches at periodic frequencies, and the notch frequencies are a function of both receiver depth and emergence angle (measured with respect to vertical). So collectively, conventional seismic data contains frequency notches related to both source ghost and receiver ghost effects. These effects notably penalize the low and high frequency content in seismic data, resulting in a limited frequency bandwidth being recovered from the earth.

Broadband seismic signal processing by wavelet transform: To better identify and map previously indiscernible potential source rock and reservoirs, high frequency, higher resolution data is needed. Recent advances in seismic acquisitiontechniques allow for gathering wider bandwidth data in the field, however the cost is high compared to conventional methods. An alternative, more cost-effective approach for mitigating the limits in bandwidth of seismic data can be performed in processing. As the seismic signal travels through the earth the loss of bandwidth (high and low frequencies) due to absorption, dispersion, and other viscoelastic effects reduces the resolution of any seismic data. This loss of resolution complicates the interpretability of the data and increases the risk associated with prospecting.According to the Rayleigh criteria, conventionally acquired and processed seismic data is band-limited, thus allowing for identification of beds only as thin as ¼ of the domant wavelength. However, Widess (1973) proved that a reflected event does have information within the wavelet that is beyond the dominant frequency of the data, which is indicative of a bed's thickness. In fact high frequencies can be restored in the data leading to a resolution thickness as thin as 1/8 the dominant wavelength, twice as thin as previously thought.The Continuous Wavelet Transform (CWT) domain is not limited by a stationary input time series assumption, consequently it permits the analysis of both local information and global information simultaneously (Smith et al., 2008).This implies the transformation of local information (i.e., reservoir thickness) into global information (i.e., discrete frequencies within a wavelet).Broadband data has more variations in reflectivity which reveals more internal geologic features.Processing methodology using the Continuous Wavelet Transform can increase the seismic bandwidth substantially, such that the depth resolution can be enhanced. By increasing the seismic bandwidth by one or more octaves using the Continuous Wavelet Transform for deghosting and bandwidth enhancement, ability to resolve stratigraphic sequences can be improved .One important feature of the CWT method is that it analyses the seismic to find the fundamental frequencies and then computes the harmonics and sub-harmonics from the reflected data. When the convolution-like process is used to add these frequencies back to the data, the input wavelet is reshaped, thus broadening the spectrum. Any harmonic and sub-harmonic frequencies that do not match the reflectivity in the input data will not be added, meaning that noise amplitudes are not enhanced at the same level as signal, resulting in a good signal-to-noise ratio in the enhanced low and high frequencies. The frequency enhancement is verifiable and consistent with geology.With the addition of low and high frequencies to the data one can estimate the increase in vertical seismic resolution. The broadband data reveals more than one thin bed and a wedge feature which is not visible on the standard data set, also identified by a red arrow. The enhanced resolution allows for better definition of thin beds which can improve the accuracy of the stratigraphic interpretation.The increase in frequencies on both the low and high ends and the corrected ghost notches in the spectrum allow for clearer definition of thin beds in and around the target zone.In addition to the loss of usable frequencies due to viscoelastic effects, there are other non-dissipative phenomena that also contribute to the narrowing of the bandwidth, namely interfering patterns produced by the self-interactions of seismic waves. One of these interference patterns that contaminates the input data is known to the oil and gas industry as ghost reflections, and is a consequence of having sunken sources and receivers which produce secondary reflections off the air-water contact. This interference pattern is responsible for variations in seismic amplitudes and frequencies, which can lead to amplitude brightening or dimming of the signal as well as tuning. If left unresolved, these distorted amplitude anomalies could lead to seismic misinterpretation and could also be false indicators of hydrocarbons. The lack of high frequencies results in a blurring of the data as the wavelet becomes broader and flatter, making the exact locations of reflectors more difficult to ascertain. Low frequency loss causes the wavelets to have high frequency side lobes which make the seismic appear ‘ringy’ and produces spurious apparent reflections surrounding the true reflections. Both effects must be corrected in order to achieve broadband, high resolution marine seismic data.

Wavelet Analysis of seismic signal: Wavelet analysis and mathematical microscope are excellent techniques to check health & wealth of petroleum reservoir.WT analysis is their property of being localized in time (space) as well as scale (frequency). This provides a timescale map of a signal, enabling the extraction of features that vary in time. This makes wavelets an ideal tool for analyzing signals of a transient or non-stationary nature. Complex Wavelet Transform is used to rectify and pacify limitations; shift sensitivity, poor directionality, and absence of phase information. Based on wavelet transform multi-resolution analysis, spectrum is determined. Using relationship between wavelet transform modulus maxima and singular point, it can determine location of signal singular point and singular exponent of singular signal. The signal singular point location can be analyzed, the local singularity is prescribed by Lipschitz index. Wavelet analysis is an effective tool for detecting signal singularity. In each singularity point *t*, the coefficient of wavelet transform $Wx(s, t)$ is expressed as: $Wx(s, t) \leq As$v, where *s* is the transform scale, *v* the Lipschitz index, and *A* is a constant. Wavelet coefficient is closely related to the local singularity of a signal. Wavelet transform can analyze the signal elements at certain frequency band and time section, which has good time frequency localization and can seize character of instantaneous changing signals accurately and focus any details of signal for frequency through gradually meticulous sampling step of time field and frequency field.

The function $f(t) \epsilon L^2(R)$) is square integrated function; Ψ (t) is basic wavelet or mother wavelet. Series of wavelet functions $\Psi_{ab}(t) = \frac{1}{\sqrt{|a|}} \Psi(\frac{t-b}{a})\, dt$ are called wavelet function family. Wavelet transformation of *f* (*t*) is

$$Wf(a,b) = \frac{1}{\sqrt{|a|}} \int_{-\infty}^{+\infty} f(t)\, \overline{\Psi\left(\frac{t-b}{a}\right)}\, dt$$

In the Ψ_{ab}(t)the parameter "*a"* governs frequency of the wavelet; parameter "*b"* gives its position. In actual signal processing, discrete wavelet transform and multi resolution analysis are often used.

Conclusion

Geophysical Signal Processing is of paramount importance for precisely imaging subsurface geological features. My research work assigns to delve deep into so many methods, techniques and tools for statistical nonstationary geophysical seismic signal processing and imaging - Wavelet Analysis **,**Principal Component Analysis (PCA), Factor Analysis, Independent Component Analysis (ICA), Blind Source Separation,spectral analysis and Singular Value Decomposition(SVD), Azimuthal Seismic Processing, Subsurface imaging by seismic diffractions, Nonlinear Seismic Imaging, etc.One of the drawbacks of the filter -based frequency decomposition techniques, such as Fast Fourier Transform(FFT) or Wavelet Transform(WT), is that the vertical resolution of the original seismic data is not preserved due to vertical smearing(bleeding effect). Geophysical signals are multiscale andnonstationary in character.Themultiscale decomposition of the seismic data takes into account the timescale localization properties of the wavelet transform. The adaptative filter works in the following way. The decomposition represents the seismic data in several scales. So, for a given scale, the ground roll becomes more localized in the timescale domain and therefore can be more easily subjected to a surgical removal.Seismic waves have different waveforms, and mathematical morphology method is capable of seeking the tiny differences between them, so different sections categorized by their waveforms can be obtained, which is called multiple scales decomposition.Structure elements of mathematical morphology play a vital role in the shape feature extraction of the signal and image, but a structure element with a given shape can only handle target bodies which have big differences in shape but cannot handle target bodies which have similar shapes and different sizes. So another property, scale, should be introduced. Given a structure element sequence in which all structural elements have the same shape but different sizes we then can process the signal and image according to the shape and size of structural elements at the same time. This algorithm which uses different scales of structural elements for morphological transformation is called multi-scale morphology .Seismic signal processing is an important task in geophysics sounding and represents a permanent challenge in petroleum exploration. Although seismograms could in principle give us a picture of a geological structure, they are very contaminated by spurious signals and the ground roll noise is a strongly undesired signal present in the seismograms – it does not carry physical information about the deep geological structures.Multi-scale morphology has a wide range of applications in seismic data processing. It can be applied to suppressing surface waves and interfering waves , detecting seismic fractures ,and removing multiple waves. Applications Multiscale signal & image processing seismic subsurface imaging ,Multiscale full waveform inversion, multi scale seismic tomography, seismic image processing -analysis/understating-interpretation(splicing&quilting) Image processing(image to image),Analysis(image to attributes),Understanding-interpretation(attributes to attributes);3D seismic attributes enhancement and detection by advanced technology of image analysis,image that contains large scale edges as well as textures with small scale features,Image structure analysis for seismic interpretation; 3D seismic image processing for unconformities and Graphic processing unit,edge detection -sobelfilter,etc.Multiscale seismic characterization of marine sediments by using a Wavelet transform- wavelet-based method to characterize acoustic impedance discontinuities from a multiscale analysis of reflected seismic waves continuous wavelet transform(CWT) of a seismic trace involving such a finite frequency bandwidth can be made equivalent to the CWT of the impulse response of the subsurface and is defined for a reduced range of dilations, controlled by the seismic source signal. In this dilation range, the multiscale seismic attributes are corrected from distortions and we can thus merge multiresolution seismic sources to increase the frequency range of the mutliscale analysis. Seismic attributes have been widely used in hydrocarbon exploration and exploitation. However, owing to the complexity of seismic wave propagation in subsurface media, the limitations of the seismic data acquisition system, and noise interference, seismic attributes for seismic data interpretation have uncertainties. Especially, the antinoise ability of seismic attributes directly affects the reliability of seismic interpretations. Gray system theory is used in time series to minimize data randomness and increase data regularity. GrayDetrended fluctuation analysis (GDFA) can effectively reduce extrinsic data tendencies. Nonlinear time series is generated by the Weierstrass function and add random noise to actual seismic data. Denoising ability of the fractal scaling exponent based on GDFA is employed FOR calculating fractal scaling exponent as a seismic attribute which can decipher distribution of sedimentary facies.Weierstrass' approximation theorem; Weierstrassfunction,wachspress patches applications in seismic imaging geophysical migration mapping.

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