AAPG Datapages/Search and Discovery Article #90255 © 2016 AAPG/SEG International Conference & Exhibition, Barcelona, Spain, April 3-6, 2016

Quality Enhancement of 3D Seismic Data Using Anisotropic Diffusion Method

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Abstract

Having high quality images of seismic sections is one of the most important issues for interpreters. In order to delineate geological features and sedimentary packages such as faults, channels, and etc., many attempts carried out to attenuate unwanted noises caused by improper environmental and acquisition parameters and processing artifacts. Different types of noise in seismic data reduce the signal to noise ratio and then decreasing the quality of the data. Thus, the aim is to reduce this noise in order to produce a series of high quality images so as to delineate features for detail structural interpretation and quantitative studies.

In this paper, we propose a method based on Anisotropic Diffusion which is aiming at reducing noise without destroying significant parts of the image content, typically edges or other details that are important for the interpretation. Anisotropic diffusion is a process that produces a family of parameterized images. Each resulting image is a convolution between the original image and a 2D isotropic Gaussian filter that depends on the local content of the original image. Accordingly, anisotropic diffusion is a non-linear and space-variant transformation of the basic image. As this technique has special abilities in noise attenuation and preserve structures in the filtered image as well, it can be utilized for 3D seismic data enhancement.

For this purpose, at first three-dimensional stacked data is sorted out to its time-slices; indeed, each time slice is a digital image which includes both signal and noise. As a consequence of this transform, signals are presented as coherent events, and noise as random amplitudes. This technique is applied on each time slice separately in order to reduce the noise and subsequently increase signal to noise ratio. Finally, filtered time slices are returned to the original three-dimensional stacked data.

Efficacy of this method in enhancing data quality and in highlighting small features is presented using synthetic and real data examples. Based on this work we have derived an efficient method for random noise rejections in images and multidimensional data, while important details of data are preserved. Results from applying the method on a 3D stacked data and comparing them to outputs of other conventional methods such as Singular Value Decomposition (SVD) is presented to confirm the effectiveness of this strategy for different interpretive scenarios.