Structure-Oriented Texture Model Regression for Seismic Structure Visualization and Interpretation

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ABSTRACT

Regular wiggle-trace imagery of seismic amplitude has hampered interpreters' ability to visualize structural details due to the low dominant frequency and signal-to-noise ratio of wiggle traces. To overcome the limitations, this study introduces a structure-oriented texture model regression method to transform a regular wiggle-trace data set to a structurally enhanced data set. The algorithm first constructs a texture model using a full wavelength of trigonometric sine function with a specific amplitude, frequency, and phase. Then it performs least-squares linear regression analysis between the model and the seismic data at each sample location along each trace throughout the volume. Instead of calculating the regular regression gradient, the algorithm takes the absolute value of regression gradient to create an absolute regression gradient volume.

The structure-oriented texture model regression process has major advantages that contribute to the improved seismic structure visualization and interpretation. First, because texture in the subsurface can be significantly modified by deformation, seismic texture analysis provides a new perspective for improved visualization and interpretation of seismically imaged structural features. Second, least-squares linear regression of image texture is a statistically robust filtering process that can help enhance signal-to-noise ratio. Third, the trigonometric sine function as a regression model retains phase information of wiggle traces that is critical to seismic structure analysis. Lastly, taking the absolute value of regression gradient increases frequency of reflection events and dynamic range for texture discrimination, and thus has direct impact on visibility and resolution for seismic structure and facies. Case studies and comparative analysis indicate that the structure-oriented texture model regression contributes significantly to improved visualization of structural details that are not easily recognizable from regular wiggle trace and conventional seismic attribute data.